PipeCAD System Design and Installation User Guide

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Content

Important information

Regulatory information

EN installations:

For EN 54-20 compliant installations, the Class of any pipe/hole configuration and the detector sensitivity must be determined using the PipeCAD software.

UL Installations:

Kidde Products Ltd. Chlorinated Polyvinyl Chloride (CPVC) Air Sampling Smoke Detection Pipe is UL Listed for use with all of our aspirating smoke detection systems listed in accordance with the appropriate requirements. Kidde Products Ltd. Air Sampling Piping System products may be used with other manufacturers' products. However, specific application approvals may not be identical among manufacturers. It is the installer's responsibility to verify suitability of products used in conjunction with the air sampling pipe installation according to each manufacturer's installation instructions.

Kidde Products Ltd. Air Sampling Piping System products are approved for use in air plenums. The intake and exhaust piping should be UL category QNVT rated.

Kidde Products Ltd. Air Sampling Piping System products have been investigated by UL per the requirements of UL 1887, and found to comply with the combustibility requirements for thermoplastic sprinkler pipe as described in the *Standard for Installation of Air-Conditioning and Ventilating Systems*, NFPA 90A and various model mechanical codes.

Limitation of liability

Note: This manual is to be used by qualified and factory-trained personnel, knowledgeable of NFPA standards and any other applicable standards in effect.

This manual is intended to provide guidance to qualified technical professionals for the design, installation, operation, and maintenance of the Kidde Products Ltd. Air Sampling Piping System.

Only qualified persons experienced and trained in the installation of this type of equipment should install and configure the Kidde Products Ltd. air sampling piping system. They must be familiar with relevant NFPA and all applicable codes, and must be trained and qualified by Kidde Products Ltd. Kidde Products Ltd. is a manufacturer of the components that make up the Kidde Products Ltd. Air Sampling Piping System and is not responsible for the installation, configuration, operation, maintenance, and testing of the system. It is the responsibility of the professional installer (described above) to properly install and configure the systems. Under no circumstances will Kidde Products Ltd. be liable for improper installation, maintenance, testing, or configuration of the systems.

The technical data contained herein is provided for informational purposes only, and should not be used as a substitute for professional judgment. Although Kidde Products Ltd. believes this information to be true and correct, it is published and presented without any guarantee or warranty whatsoever. Kidde Products Ltd. disclaims any liability for any use of the data other than as set out in this manual, foreword included.

This manual provides instructions for handling and installing a Kidde Products Ltd. Air Sampling Piping System. Due to the life safety and loss prevention uses of such systems, it is imperative that all information within this manual is thoroughly understood before starting the installation. Kidde Products Ltd. requires that all air sampling smoke detection systems using Kidde Products Ltd. Air Sampling Piping System products be installed in accordance with this manual.

Advisory messages

Advisory messages alert you to conditions or practices that can cause unwanted results. The advisory messages used in this document are shown and described below.

WARNING: Warning messages advise you of hazards that could result in injury or loss of life. They tell you which actions to take or to avoid in order to prevent the injury or loss of life.

Caution: Caution messages advise you of possible equipment damage. They tell you which actions to take or to avoid in order to prevent the damage.

Note: Note messages advise you of the possible loss of time or effort. They describe how to avoid the loss. Notes are also used to point out important information that you should read.

Safety summary

Note: The following must be observed to maintain personnel safety.

The following general safety notices supplement specific warnings and cautions appearing in the manual. The safety precautions in this section must be understood and applied during operation and maintenance.

Test equipment

Make certain test equipment is in good operating condition. Do not touch live equipment or personnel working on live equipment while holding a test meter. Some types of measuring devices should not be grounded; these devices should not be held when taking measurements.

First aid

Any injury, no matter how slight, should never go unattended. Always obtain first aid or medical attention immediately.

General precautions

The following general safety precautions are to be observed at all times:

- All electrical components associated with equipment should be installed and grounded in accordance with local regulation requirements.
- Special precautionary measures are essential to prevent applying power to equipment at any time when maintenance work is in progress.
- Before working on electrical equipment, use a voltmeter to ensure that the system is not energized.
- When working near electricity, do not use metal rulers, flashlights, metallic pencils, or any other objects having exposed conductive material.
- When connecting a meter to terminals for measurement, use a voltage range higher than expected voltage to be measured.

Chapter 1
General information

Summary

This chapter provides general information about the PipeCAD modeling software.

Content

Introduction

This manual provides instructions for designing and installing an air sampling pipe system. Due to the life safety and loss prevention uses of such systems, it is imperative that all information within this manual is thoroughly understood before starting the installation.

For UL installations, the manufacturer requires that all air sampling smoke detection systems using our CPVC Air Sampling Smoke Detection Pipe products be installed in accordance with this instruction manual and all applicable codes and standards.

System description

Aspirating smoke detection is a system that uses an aspirating fan to draw air from the protected area via a network of sampling pipes and sampling holes. The sampled air is passed through a high-sensitivity precision detector that analyzes the air and generates warning signals when appropriate.

This system has a number of benefits, particularly in the areas of performance, installation cost, and routine maintenance. This guide provides an overview of this type of system, although applicable local standards and codes also must be reviewed.

About PipeCAD modeling software

PipeCAD pipe modeling software is an easy-to-use “next generation” computer-aided design tool which assists the designer of high-sensitivity aspirating smoke detection systems. The program allows the designer to draw a schematic view in three dimensions on a PC screen by use of a 3D snap grid. System layouts can be modified, stored, retrieved, and evaluated to provide optimum performance of the area to be protected.

Note: PipeCAD cannot be used to model or design systems which use other manufacturers’ detection equipment.

This program has the unique ability to actually assist in the design of a sampling system with its powerful analysis capability. This gives the designer, installer, and end user more confidence that the system is working at its optimum efficiency.

Caution: PipeCAD is intended as a design aid and cannot take into account other factors that can affect system performance (such as air pressure differentials which typically exist in buildings which use air handling equipment). Please contact our Technical Support department if in doubt about any aspects of system design.

About the sampling pipe network

The sampling pipe network extends into the protected areas and is arranged to allow strategically placed sampling holes to properly sample the air in these areas. The sampling pipe is typically made up of 3/4-inch pipe. The design and installation chapters of this manual contain detailed information on the construction and design of the air sampling pipe network.

Chapter 2
Applications

Summary

This chapter provides information about different applications for sampling pipework.

Content

Selecting a sampling method

Before you attempt to design an air sampling network, it is important that you understand some important information on how to use the PipeCAD pipe modeling software. The application often dictates the sampling method to be used.

The following list of typical applications can be used as a guideline for sampling method selection:

- Telephone central offices
- Computer rooms
- Clean rooms
- Atriums
- Office areas
- Museums
- Warehouse storage

Each of these applications is discussed in detail below.

Telephone central offices

A distributed sampling pipe network combined with return air grill sampling is recommended for telephone central offices. If the offices have cable trays above the equipment racks, two levels of distributed pipe network sampling are recommended. One level of extended sampling points would be at ceiling level and a second level would be below the cable trays just above the equipment racks.

The two levels can be designed in two ways: One option is to run a main pipe above the ceiling with drilled sample holes into the pipe for the first level and extended sampling points dropped down below the cable tray for the second level. Another option is to install a second level of piping below the cable trays.

In either case, a second detector is required if the length of pipe exceeds the detector’s limit (refer to “Recommended maximum pipe length” on page 28.)

Computer rooms

A distributed sampling pipe network or return air grill sampling is recommended for computer room applications. A distributed pipe network can be installed above the dropped ceiling with capillary tube sampling points installed in the drop ceiling tiles.

When using return air grill sampling, the return air is usually monitored at the top of the air handling units before the air enters the units. Both methods are effective—however, if the air handling units are shut off, overall smoke detection effectiveness will be affected. A combination of both methods provides the quickest response to particles of combustion.

If subfloor detection is required, a distributed pipe network is recommended with the sampling holes facing down or perpendicular to the airflow.

Clean rooms

Either return air grill sampling or return air duct sampling is recommended for clean room applications. The best sampling design will depend on the air handling equipment and location of the filters.

Atriums

A distributed sampling pipe network is recommended for protecting atriums. Multiple level sampling may be required, depending on the height of the atrium ceiling and the effects of stratification. Monitoring the return air grill in combination with a distributed pipe network may significantly reduce detector response time.

Office areas

A distributed sampling pipe network with capillary tube sampling points is recommended for protecting office areas. Refer to local codes for pipe type requirements. Many office areas consider the volume above the ceiling tiles as a return air plenum.

Museums

A distributed sampling pipe network combined with return air grill sampling is recommended for museums. A distributed pipe network can be installed above the ceiling with capillary tube sampling points installed in exposed areas. The return air grill or air duct sampling design will depend on the air handling equipment installation.

Warehouse storage

A distributed sampling pipe network is recommended for warehouse applications. To overcome smoke stratification, two or more levels of sampling may be required, depending on the ceiling height of the warehouse.

Air sampling pipe systems can be used in freezer warehouse applications, although it may be necessary to condition the air before it enters the detector. The detector must be mounted outside of the low temperature area.

Chapter 3
Designing an air sampling system

Summary

This chapter provides general guidance on the design of sampling pipe networks for the air sampling pipe system and detectors.

Content

Introduction

A sampling pipe network that has been correctly designed for a given application will be more efficient and therefore offer significantly higher performance. All of our high-sensitivity smoke detectors incorporate ClassiFire artificial intelligence. This feature supports the designer in engineering systems to protect a very wide range of applications, including those having diverse environmental conditions.

This chapter contains instructions for the proper design of a sampling pipe network. Most of this chapter covers the pipe network design, which must be accomplished prior to installation of any components of an air sampling pipe system. The information provided in this manual is intended as an overview only.

Regulatory requirements

The design of aspirating systems, while generally simple, requires that certain specific rules be followed for NFPA and EN compliant system performance. Consideration must be given to all of the relevant local codes of practice, standards, and regulations that are used to govern the design of detection systems. The designer must bear in mind that these regulatory documents may deal with the *minimum* acceptable requirements, often related to the performance and cost of “conventional” detectors, for a very general range of applications.

For EN 54-20 compliant installations, the Class of any pipe/hole configuration and the detector sensitivity must be determined using the PipeCAD software.

Planning the air sampling network

This manual does not offer specific planning guidelines but recommends a basic planning procedure that should be used to make sure that all the elements that affect the system design are considered.

Before beginning the planning and design of an air sampling network, it is important to determine what is expected from the installed sampling pipe network.

For UL installations, the hole spacing in the pipe network must meet or exceed NFPA requirements for the spacing of spot-type smoke detectors.

System types

There are two main types of aspirating smoke detection systems:

- Primary
- Secondary

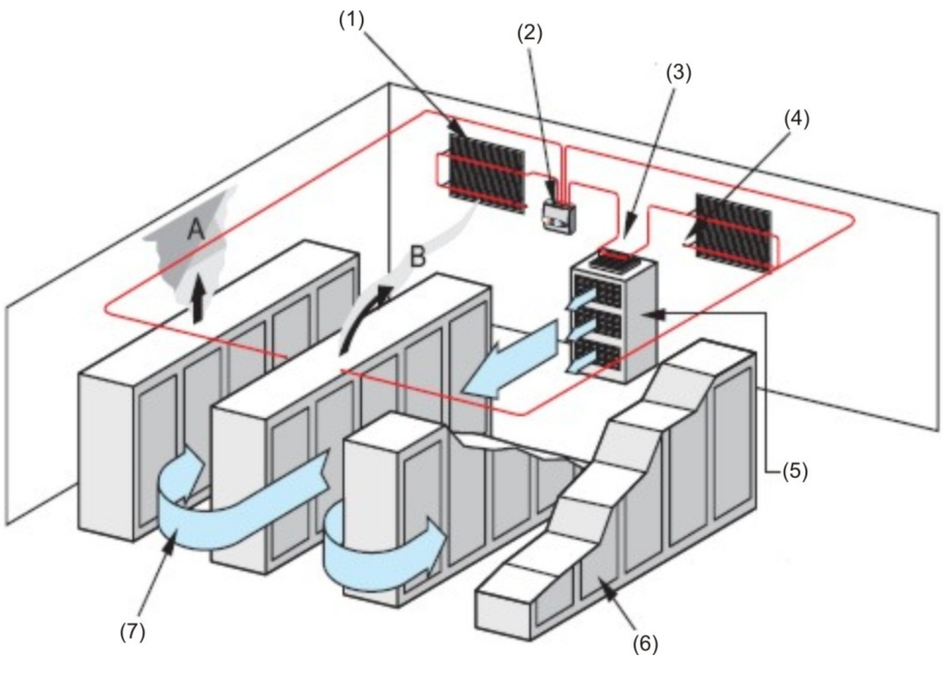
Primary sampling system

A primary sampling system is a system that is designed to work in conjunction with any air handling or ventilation systems already in place. A primary sampling system will not provide optimum performance when these handling or ventilation systems are inoperative; however, an advantage of this type of system is that it can detect small quantities of cool smoke from a minor incident that would not normally rise to the ceiling—the “conventional” location for a smoke detection system. A primary sampling system is often used as an “early warning” detection system in conjunction with a conventional point detector system. The aspirating system could be used to switch off or reduce the mechanical ventilation which allows the point detection system to operate effectively. Figure 1 below illustrates a primary sampling system which works in conjunction with an air handling system.

A = Smoke path - static air

B = Smoke path - maximum ventilation

Figure 1: Primary sampling performed via air handling system

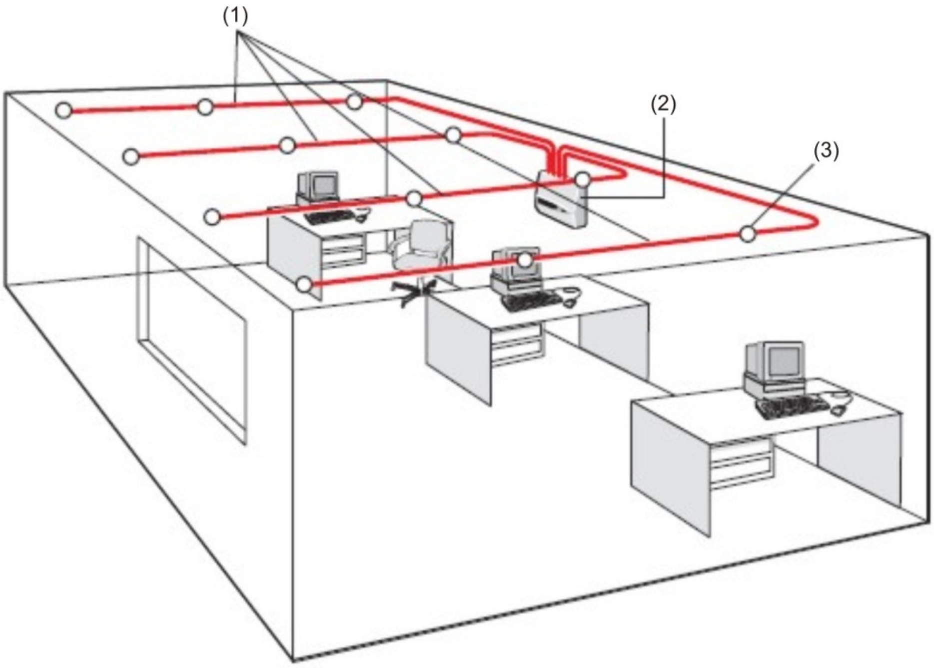


(1) Pressure relief vents
(2) Detector
(3) Bypass vent
(4) End cap
(5) High velocity forced air cooling unit
(6) Equipment cabinets
(7) Path of high velocity air
A Smoke path - static air
B Smoke path - maximum ventilation

Secondary sampling system

A secondary sampling system is designed with sampling holes in the same relative positions as normal point detectors. Figure 2 on page 12 illustrates a secondary sampling system with normal point detection.

Figure 2: Secondary sampling — layout for normal point detection



(1) Sampling pipe network
(2) Aspirating smoke detector
(3) Sampling points

The sampling pipe network and system sensitivity may also be designed and adjusted to achieve one of two levels of sensitivity:

- Normal Sensitivity: The same sensitivity as normal ionization detectors, typically 0.8% to 1.5% obscuration per foot (2.6% to 5% obscuration per meter).
- High Sensitivity: Responding to smoke at concentrations of less than 0.8% obscuration per foot (2.6% obscuration per meter).

The obscuration values refer to the sensitivity at each sampling hole and not the claimed sensitivity of the detector. This is discussed in more detail "Understanding basic design principles" on page 28. Pipe network design terms and details

The terms in the following paragraphs are used in the design of an air sampling pipe system. It is important to become familiar with these terms and their meanings prior to installing the pipe network.

Air sampling pipe network

An air sampling pipe network is an arrangement of pipes located within the protected area through which air is drawn back to the detector to be analyzed.

Note: It is important to ensure that all joints in the sampling pipe network are airtight and that the system is adequately supported to prevent air leakage, as this could affect system performance.

Air velocity

Air velocity is the speed of air that passes a sample hole. The air velocity can be measured with a hand-held anemometer, as shown in Figure 3 below. Hold the meter near the proposed position of the sampling point and rotate the meter to obtain the maximum reading. All related building systems that may have an effect on the airflow patterns of the protected areas, such as HVAC systems, should be operating when the measurements are taken. These measurements must be recorded for use when designing the pipe network in the PipeCAD pipe modeling software.

Figure 3: Hand-held anemometer

Elbow, standard 90-degree

A standard 90-degree elbow is similar to that used in the plumbing industry. Each elbow increases the resistance of the system. Systems should be designed to minimize the number of elbows.

Extended sampling point (ESP)

Extended sampling points are extensions of pipe from the pipe segment to the area being protected. A typical use of an extended sampling point would be to drop a sampling point down from the main pipe segment into the protected area.

Sampling point (SP)

Sampling points are plastic pipe network fittings designed for drop ceiling installations. The sample point is connected to the pipe network by 3/8 in. (9.5 mm) capillary tubing and is predrilled with a 1/32 in. (0.8 mm) sample hole. Note that a 2 mm hole size (5/64 in.) is the smallest hole that PipeCAD uses in pipe network calculations.

Sampling hole

Sampling holes are strategically located penetrations into a pipe segment through which air is drawn into the sampling system. Refer to NFPA-72 or other local authorities for sample hole spacing requirements. The sampling hole size is calculated using PipeCAD software.

System transport time

System transport time is the time required for smoke to travel from the farthest sampling hole in the system to the detector.

Note: NFPA-72 requires a maximum transport time of 120 seconds. All UL listed systems must have a maximum transport time of 120 seconds.

Surveying the site

Before surveying the spaces requiring protection, the designer should determine whether or not current site drawings are available. In addition to site drawings, determine whether a specification is available that indicates what level of performance is expected from the completed air sampling system.

In addition to site drawings and specifications, the following factors should be considered.

Activities within the space

The type of activity within the space requiring protection and its physical characteristics should be considered when deciding which sampling methods should be used and an appropriate level of performance.

Some types of activities are identified below:

- Microelectronics clean rooms
- Electronic data processing rooms, communications switch rooms, control rooms
- Offices
- Public spaces such as shops, theaters, libraries, museums, conference centers, cinemas, churches
- Dormitory areas such as hotels, detention centers, barracks, hostels, hospitals
- Historic buildings
- Warehouses, factories, plant rooms
- Freezer and cold stores

Inquiries should also be made about factors that may affect decisions relating to the system design, including (but not limited to) the common or expected hours of operation, whether the space is manned or unmanned, and whether there are periods when customary activities may create unusually high levels of smoke pollution.

Physical characteristics

Some questions to consider about the physical characteristics are:

- Types of spaces requiring protection — Are they rooms, void spaces, cabinets, or enclosures?
- Floor and ceiling voids — Does the space have floor or ceiling voids? If so, do they extend beyond the space? Are they subdivided into compartments? Are there any trenches or ducts? What are the voids used for? What services already run within them? Are the voids accessible?
- Dimensions of the spaces — Measure and record the lengths, widths, and heights of the areas to be protected.
- Construction materials — What materials have been used to build the spaces? Are the materials substantial? Have any decorative materials been included? What notable fixtures are there?
- Compartments — Is the space subdivided into smaller compartments? If so, are the compartments substantial? Do walls or partitions fully enclose the compartment or does it share a floor or ceiling void with another space? Are there fire barriers across shared voids? Are the barriers complete?
- Existing fire protection systems — Are there any existing systems? If so, where are they situated?

Environmental conditions

Factors which affect the environment within the space to be protected have a very significant bearing on the particular sampling method employed to protect it. During the initial site survey, care should be taken to note the following details, which are examples and not meant to be all-inclusive:

- How is ventilation achieved within the space? In which direction does the airflow? Is a void used as a feed or return air plenum? Is the air conditioned (heated, cooled, or humidified) or filtered? If so, what standard is the filtration? What is the number of air changes per hour?
- If mechanical ventilation is employed, what are the patterns of air movement? (If these are not known, they can be determined using a small smoke generator.) Does the ventilation quickly dissipate the smoke or does it circulate in stratified flow paths? Are there any points within the area where the airflow appears static?
- Is make-up fresh air introduced into the ventilation system? If so, at what rate is it introduced? Where is the fresh air drawn from? Is the air filtered, and to what standard? If there is a real risk of polluted air entering the area, consideration must be given to installing a reference detector to reduce unwanted effects.
- Does the area rely on natural ventilation? If so, what are the sources of the natural air? Is there the possibility that external pollution could enter the space, particularly when there are variations in the prevailing winds?
- What is the normal state of the air within the area? Are the temperature and relative humidity stable or fluctuating?

- Are there any activities that can produce smoke, heat, fumes, dust, steam, or flames inside the area to be protected? If so, are they a continuous process or do they only occur at particular times?
- Is the smoking of tobacco allowed in the area?
- It is important that careful notes be taken regarding the ambient conditions, particularly any air movements, as these have considerable bearing on the design of the sampling pipe network and the location and type of sampling hole to be used.

Materials risk assessment

Having made a detailed survey of the physical and environmental characteristics of the area to be protected, careful notes should also be taken on the position and type of combustible materials present. While the purpose of providing a high efficiency detection system may be to protect a particular object, it must be remembered that, given the right circumstances, anything in the space presents a fire or smoke hazard.

It is possible that support services present the highest risk within the area to be protected. Knowledge of this assists in determining what sampling methods are to be used, where to position the sampling holes and the potential sensitivity range required from the detector.

Some examples of these types of materials are:

- Electrical and electronic cabling — Modern offices, computer rooms, and communications facilities require large quantities of cabling and connectors. These are often concealed and poorly managed.
- Paper and paper goods — these may be found in high-speed printer rooms, libraries, archives, print shops, offices, and storerooms.
- Synthetic materials and foams — these materials are usually found in furnishings, carpets, partitions, and office equipment. In modern premises, these should be self-extinguishing and of a low smoke and fume type. More hazardous, older materials may exist in older premises.
- Natural fibers and wood — Furniture and furnishings contain natural fibers and wood as well as synthetic materials.
- Flammable liquids or gels — In addition to designated storage areas, flammable liquids or gels may also be unknowingly held in considerable quantities in office storerooms.

It would also be worthwhile to select potential sites for the detector during the survey. Consideration should be given to the availability of suitable power supplies, the location of any existing fire protection systems to which the air sampling pipe system and the aspirating detector must be connected, and the suitability of the site for mechanically fixing the unit, its safety, and aesthetics. All the information, sketches, notes, and drawings form the basis of the final system design.

Logical detection

Within the overall area requiring protection, it may be necessary to distinguish between compartments or areas in which different activities are undertaken or different levels of potential risk exist. Logically dividing the complete system into subcompartments allows the aspirating detector to provide different responses or actions.

These areas are not readily described as “zones” as the detector is a detector that normally reports back to a main fire system. It is the main fire system that should determine what overall area constitutes a fire zone.

Figure 4 on page 18 provides an illustration of a modern computer suite with an automated data retrieval unit, a printer room and “bridge” or control room.

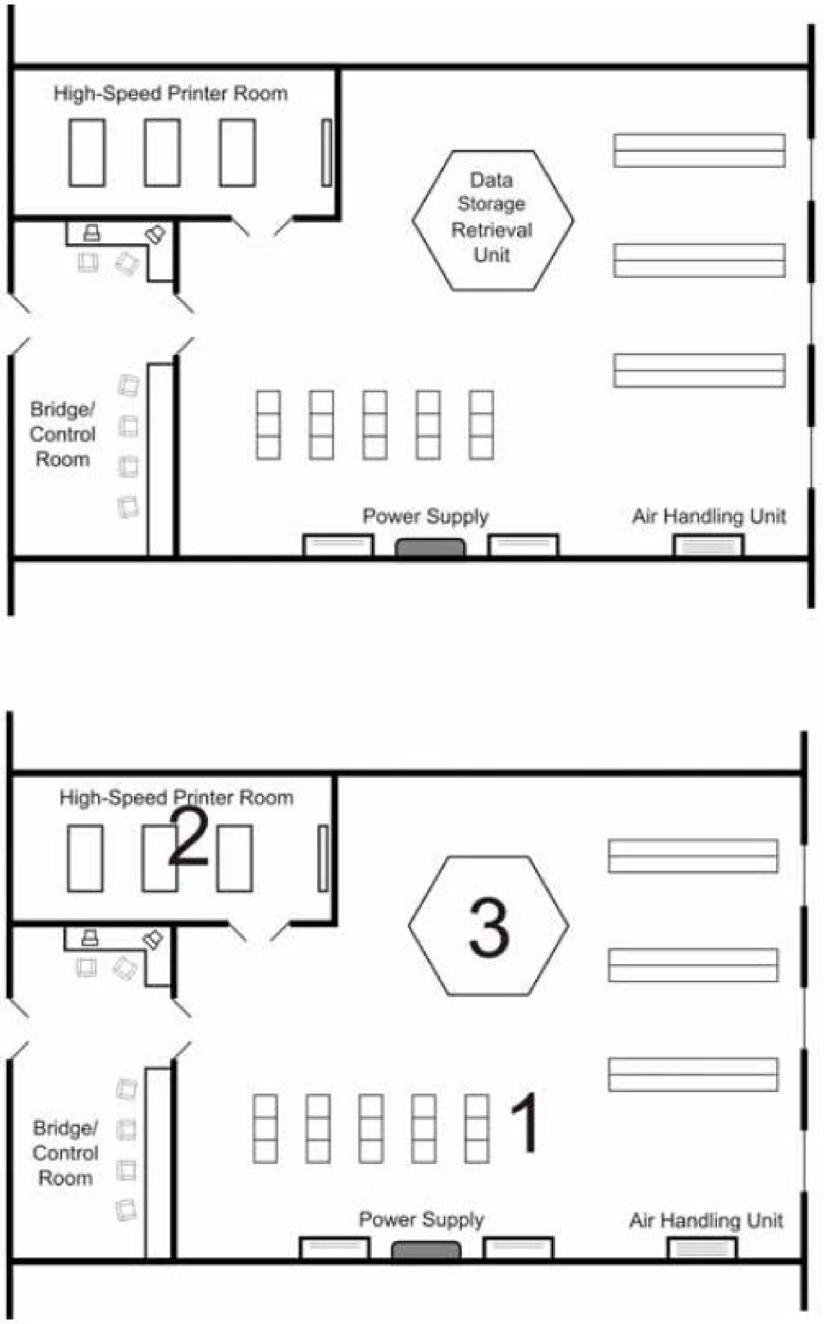
The computer room and bridge share a common ceiling, subfloor, and air handling system. The automatic data retrieval unit sits within the computer room but is sealed from it. The printer room contains its own air conditioning unit and contains partitions that extend between the floor and ceiling slab.

While the overall area of the suite can employ a single detector, the response or actions required from each are different for each part of the suite:

- The printer room has high-speed printers that need to be stopped if smoke or aerosols are detected.
- The data retrieval unit is sealed from the room and an alarm is raised the instant that smoke and aerosols are detected.
- The computer room and bridge require early warning of an incident, but no shutdown.
- A signal to the servers shifts processing to an alternative site.

A single detector could not achieve the variety of responses and levels of potential sensitivity required. Logically, three detectors are required, each detector having its sensitivity and responses tailored to the particular risk.

Figure 4: An electronic data processing suite



Sampling methods

Selecting the most appropriate sampling method involves careful consideration of the information gathered during the site survey and the requirement to design a logical detection system. The designer can then choose the most effective sampling methods for the area requiring protection. There are some circumstances where a particular sampling method, although preferred, will not be adequate or appropriate for the given area. It is the designer's responsibility to employ a sampling method that provides the maximum level of protection.

The chart shown in Table 1 on page 20 shows a range of applications and some considerations as to the appropriate sampling method for these applications. Four sampling methods are provided as options and are discussed in the following sections.

Note: Table 1 on page 20 is provided only as a general guide for assistance in choosing a sampling method. It is not intended as a definitive statement as to the appropriate sampling method for these applications. Each site has unique considerations that must be taken into account when selecting a sampling method. The designer must use the information gained during the site survey as the determining factor in the final choice of sampling method.

Table 1: Recommended sampling methods for various applications

Application	Standard Method			Return Air Duct Method	Return Air Grill Method		Capillary Method		
	Below Ceiling	In Ceiling or Floor	Above cabinet	Within Duct	Across air return	Within unit	Concealed	Drop Pipe	In-Cabinet
Aircraft hangers	✔								
Anechoic chambers				✔			◆		
Archives (paper)	✔						✔	✔	
Atria	✔			✔			O	O	
Auditoriums	✔			✔	✔		✔		
Anti-Smoking areas				✔	✔				
Cable tunnels				✔				O	
Casinos							✔	✔	
Churches/Cathedrals				✔			✔	✔	
Cinemas	O	✔				✔	✔	✔	
Cleanrooms		✔		✔	✔				✔
Freezers	◆			✔	◆				
Control rooms	✔	✔	✔		✔		✔	✔	✔
Data storage	✔			✔	✔	✔	✔	✔	
Dormitories				✔			✔		
EDP areas	✔	✔	✔	✔	✔	✔			✔
Equipment enclosures			✔	✔				✔	✔
Flight simulators			✔						✔
Flour mills	✔							✔	✔
Historic buildings		✔					✔		
Hospitals	O	O				✔	✔		
Hotels				✔			✔		
Laboratories	✔			✔	✔				✔
Libraries	O			✔		✔	✔		
Manufacturing facilities	✔		✔	✔	✔			✔	✔
Museums/Art galleries	O			✔		✔	✔		
Offices	✔	✔		✔	✔	✔	✔		
Paper mills				O					
Power stations	✔		✔	✔				✔	✔
Prisons				✔			O		
Schools	✔						✔		
Supermarkets	✔	✔		✔			✔		
Telecommunications	✔	✔	✔	✔	✔			✔	✔
Theaters	O	✔		✔		✔	✔	✔	
Warehouses	✔								

KEY:
✔ Most effective or appropriate
O Less effective or appropriate
◆ Most effective but requires special provisions

Standard pipe sampling method

A standard pipe sampling network is a distributed network of pipes that extends into the protected area with strategically located sampling holes for drawing air into the system. The pipe network should be designed to meet the needs of a specific installation in order to provide optimal coverage for the protected area.

Capillary sampling method

Capillary sampling points are plastic pipe network fittings designed for drop ceiling installations. The sample point is connected to the pipe network by 3/8 in. (9.5 mm) capillary tubing and is predrilled with a 1/32 in. (0.8 mm) sample hole. Note that a 2 mm hole size (5/64 in.) is the smallest hole that PipeCAD uses in pipe network calculations.

Always locate the sampling points in a position to which smoke may reasonably be expected to travel. For example, ceiling sampling points may not sample satisfactorily if airflow prevents the cool smoke from an incipient fire from reaching ceiling level. In such cases, sampling pipes should be located directly in the airflow (for example, in an air conditioning unit air intake). Smoke tests are recommended prior to installation of pipes to assist in determination of suitable sampling point location. For UL installations, all sample point locations must conform to NFPA 72 requirements or those of the local AHJ.

PipeCAD pipe modeling software must be used to model the sampling pipe network and determine flow characteristics of each sample port. See Chapter 6 “Introduction to PipeCAD” on page 65 for information on how to install, set up, and use PipeCAD software.

Return air duct sampling method

Duct sampling generally is the most cost-effective method of air sampling because the pipe runs are minimal and a single detector may be used to cover a larger area. The speed of response of the detector to smoke is given by the exchange rate in the rooms ventilated by the duct ventilation system. This tends to be rapid, giving early warning of any smoke present. This type of sampling is particularly suited to high-sensitivity devices, since the smoke content in the air will tend to be diluted to a level below that of point-type detectors. Also, the relatively high airflow in the duct reduces the effectiveness of point-detection devices.

The duct sampling method does have one major disadvantage. If the ventilation becomes inoperative, the airflow through the duct system ceases and the smoke-detection system becomes ineffective.

Our HSSD detectors are UL 268A and CAN/ULC-S529 approved for duct applications with an operating air velocity range of 300 to 4000 ft./min (1.52 to 20.32 m/sec).

The following guidelines apply:

- Only one duct can be monitored per detector.
- If the air sampling pipe system and aspirating detector is used as the primary smoke detection system, methods should be employed to notify stoppage of airflow in the ducts.
- The exhaust air from the detector must be returned back to the duct using an exhaust-port adapter and associated piping. This requirement assures positive airflow through the detector.

- Locate sampling pipe in the main supply duct return side, downstream of the filters and a minimum of six duct widths from any source of turbulence (such as bends, inlets, or deflection plates) to reduce the effects of stratification. In installations where the filter is capable of removing smoke, install the sampling tube upstream of the filter.

  Note: Where it is physically impossible to locate the sampling pipe in accordance with this guideline, the sampling pipe may be positioned closer than six duct widths, but as far as possible from inlets, bends, or deflection plates.
- Locate the sampling pipe such that dampers do not restrict airflow at the sampling pipe.
- The sampling pipe should be located before air exhausts from the building or before diluting return air with outside air.
- For accurate identification of the source of an alarm, locate sampling pipe as close as possible to the protected area's air entry into the duct system.
- Locate sampling pipe on the downstream side of the filter to sense fire in the filters.

  Note: If filters are blocked, sufficient airflow may no longer be present for proper operation.
- Do not locate sampling pipe near outside air inlets except to monitor smoke entry to the handling system for adjacent areas.
- Whenever possible, locate sampling pipe upstream of air humidifiers and downstream of dehumidifiers.

Note: Deviation from these recommended guidelines may reduce the performance of your air sampling pipe system and detector.

Return air grill sampling method

Return air grill sampling is air sampling through a pipe network in front of, or near the return air grill. This method of air sampling is very effective in applications that have high volumes of air moving through their air handling system. Return air grill sampling combined with another sampling method in an application will provide maximum coverage. Typical examples of these applications are: computer and related rooms, telephone switch rooms, microelectronic clean rooms, atriums, and auditorium areas.

When using the air grill sampling without another sampling method, the smoke-detection system will be ineffective when the ventilation system is inoperative. If this method is being used as the primary smoke detection system, the grill should be monitored for stoppage of airflow.

Mapping the sampling pipe network

Once a choice has been made on a sampling method or methods for the areas requiring protection, the designer can begin the process of producing a map of the sampling pipe and air sampling hole network. Basic criteria such as hole spacing and other recommended practices for sampling pipe network design are detailed in the following paragraphs.

Basic do's and don'ts

Sampling pipe design requires the designer to follow fundamental rules. Deviating from the rules summarized below affects the performance of the system:

- Locate sampling points only in positions to which smoke may reasonably be expected to propagate, while maintaining the necessary listing authority's guidelines for coverage. Failure to correctly locate sampling points increases the dilution of smoke entering the detection system and reduces performance.

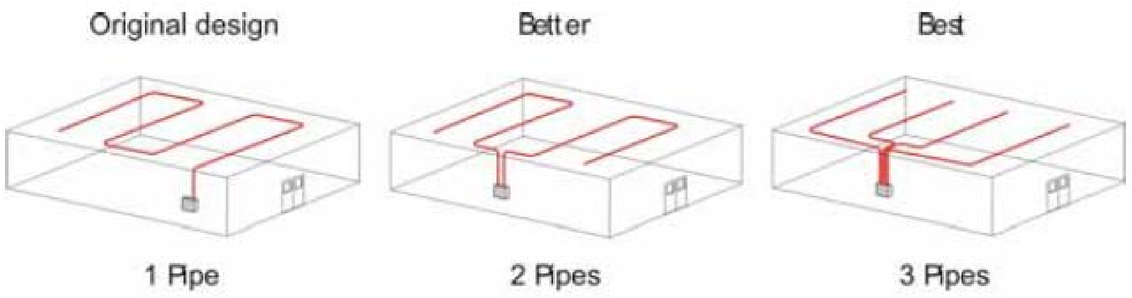
  For example, in high airflow environments, it is unlikely that satisfactory performance will be achieved with ceiling-mounted sampling points. The cool precombustion particles generated by an electrical overload are unlikely to have sufficient thermal buoyancy to allow smoke particles to rise to ceiling level. Locate sampling points at the air intake to A/C systems and not at ceiling-mounted sampling points.
- Be aware that areas of differing air pressures may give unreliable or incorrect data. Areas employing "close-control" air conditioning, such as computer environments with underfloor and room areas may have significant air pressure differentials between different parts of the protected area. In extreme circumstances, the suction generated by any aspirating detection system may not be sufficient to draw air to the detection chamber.
- Verify the system test method before undertaking design, offer, and installation. Acceptance criteria for the project may determine a greater or lesser quantity of detectors.

The designer will require scaled drawings or plans of the area for this process. If these are not available, basic drawings will need to be produced from the information recorded during the site survey.

The primary objective in mapping the sampling pipe network is to decide the location of sampling holes to achieve the performance required and also to satisfy the requirements of any code, standard, or regulation applicable to the installation. The secondary objective is to determine the optimum position for the detector.

While attempting to achieve maximum coverage, the designer should attempt to minimize the overall length of sampling pipe required and to maintain a minimum variation between pipe lengths. The optimum position reduces sample transport times through the sampling pipe network (see Figure 5 below). Wherever practical, the designer should attempt to use as many of the four air inlets available (for four-pipe detector) to assist in minimizing the transport times of sampled air through the network. See “Understanding basic design principles” on page 28 for details.

Figure 5: Advantage of multiple sampling pipes



Smoke sample takes a long time to travel from the far end of the pipe	Smoke sample takes half as long to reach the detector	Smoke sample transit time is one-third the original design

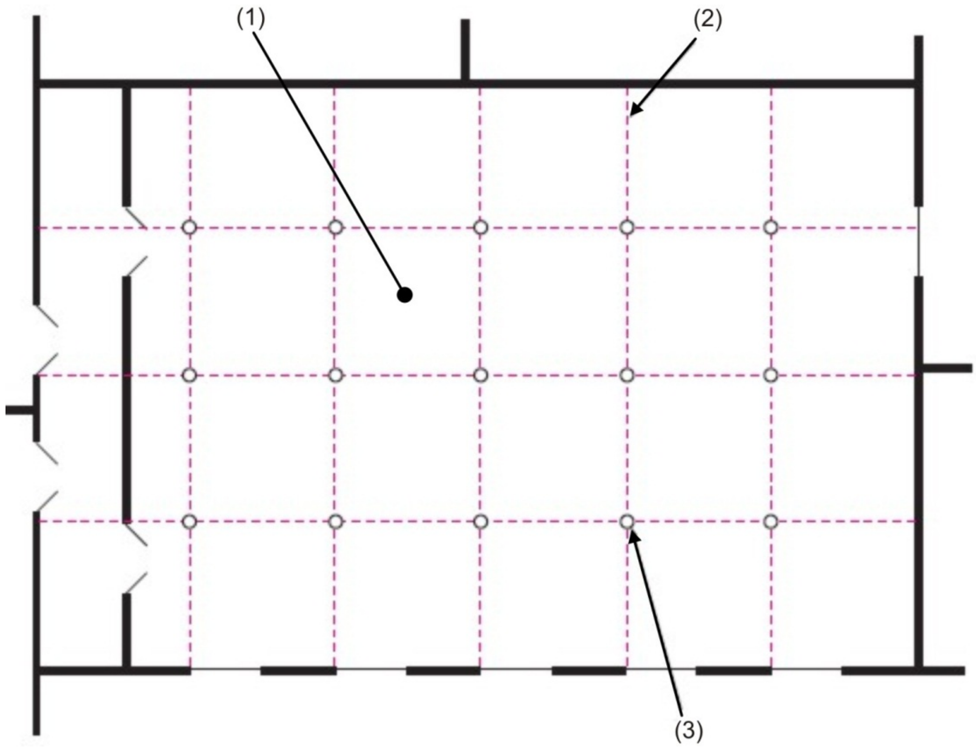
Using grid overlays

Laying a tracing overlay grid on the area to be protected is a convenient method of designing a sampling pipe network. Grid units can be square or rectangular.

Grid overlays can be used where a secondary type of detection system is required. Up-to-date scaled drawings of the site or accurate outline drawings produced from information collected during the site survey are necessary to use a grid overlay.

The designer can then produce an equivalent-scale square grid overlay whose dimensions are based on the minimum or maximum sampling point separation specified in the standard or code of practice applicable to the project. Care should be taken that sampling holes fall within those maximum distances from side walls and corners that are often required in standards or codes. Figure 6 on page 25 illustrates the principle.

Figure 6: Using a tracing overlay square grid on the plan of the area to be protected



(1) Customer call center
(2) Grid overlay
(3) Sampling point

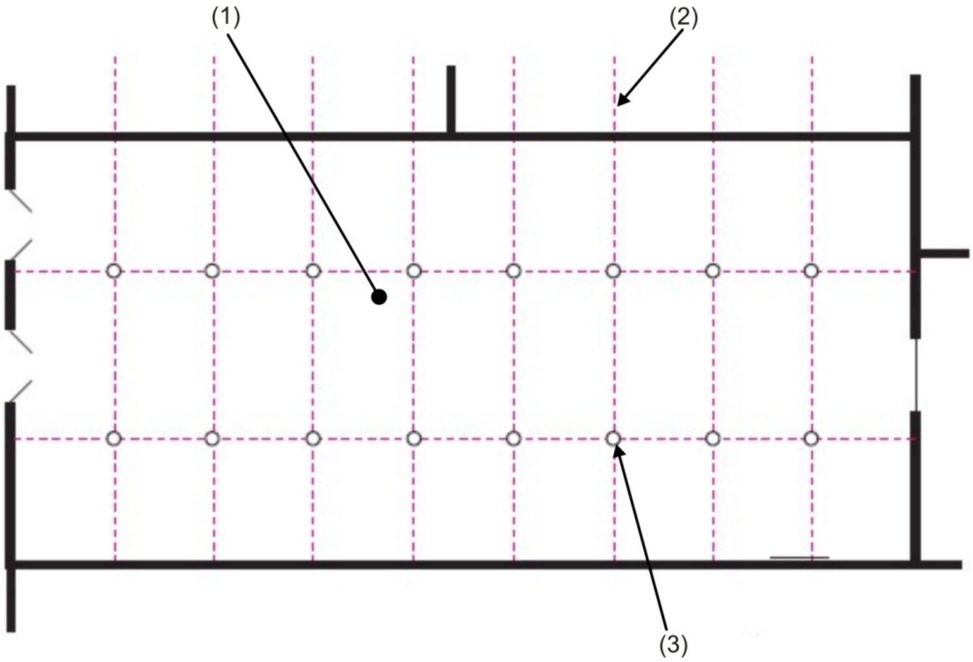
For those designers who are often involved with aspirating smoke detection systems, it may be worthwhile to draw up a set of overlay sheets in the most common scales, for example 1:50, 1:100, 1:200.

There are often cases where a square grid arrangement is not suitable and a rectangular grid would be appropriate. These are usually:

- In small areas that may only practically accommodate one or two sampling pipe runs.
- Larger spaces whose area would place the sampling holes outside the maximum limits for sampling hole separation when using a square grid overlay.

In a smaller area, a rectangular grid may be used that decreases the spacing of sampling points in one direction while maintaining the specified spacing in the other direction. Figure 7 on page 26 illustrates how this is done.

Figure 7: Using a rectangular grid overlay

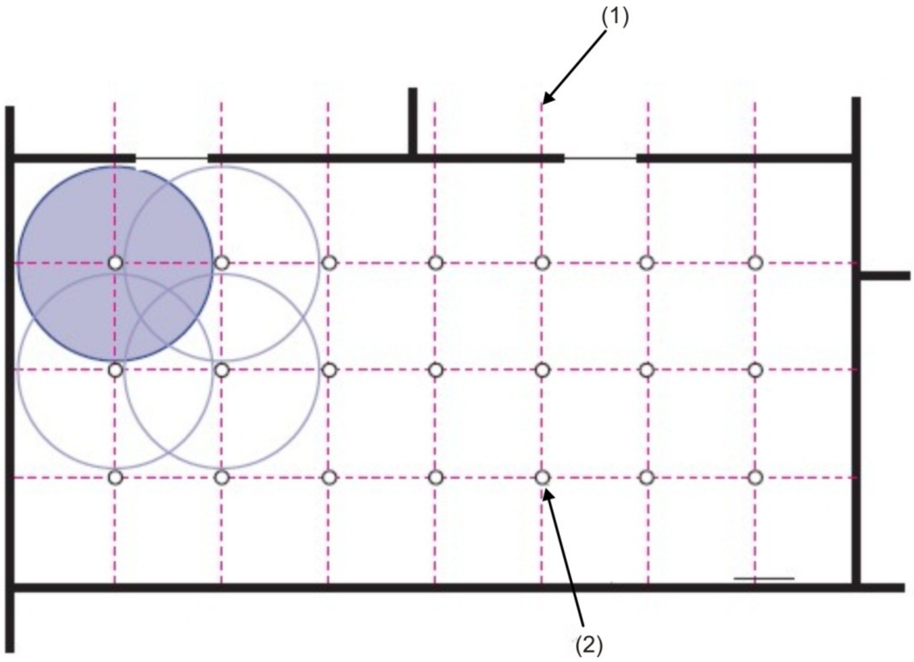


(1) Equipment hall
(2) Grid overlay
(3) Sampling point

Where the required square grid overlay does not give adequate cover over a larger area, it would be necessary to reduce the grid size from, for example, 26 ft. (8 m), to 19 ft. (6 m). This reduction is likely to require an additional sampling pipe run. The increased density of air sampling points would be beneficial, providing the total number does not exceed our recommendations. See “Understanding basic design principles” on page 28 for details.

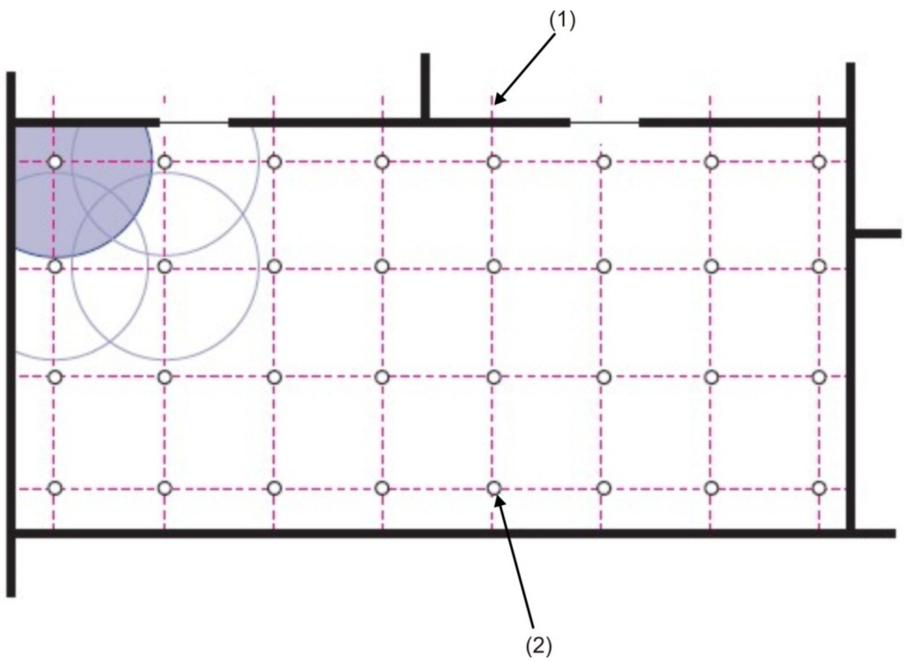
If a satisfactory pattern of sampling holes is not possible using one detector, then it may be necessary to use a second detector and associated sampling pipe network. This has the benefit of the same area being protected by two detectors with smaller sampling pipe networks. Refer to Figure 8 and Figure 9 for examples of how to meet coverage requirements.

Figure 8: An unacceptable layout — the radius of cover does not meet requirements



(1) Grid overlay
(2) Sampling point

Figure 9: Using a rectangular grid overlay



(1) Grid overlay
(2) Sampling point

Compared to the spacing of detectors required by various codes and standards, the spacing of sampling holes in these examples may seem excessive. It must be remembered that the spacing required by these codes are almost wholly related to the cost and performance of conventional point smoke detectors, whereas the cost of drilling a few more sampling holes is almost negligible.

At this stage of the process, the designer should have produced a provisional sampling pipe network design that includes the position of the sampling pipes and air sampling holes. If a specification was not available, a provisional specification should be produced that qualifies what type of system is offered and its performance expectations. For example, what published performance test specification is the system intended to achieve or surpass?

Understanding basic design principles

There are basic principles that should be understood when designing the sampling network, all of which have an effect on the performance of the aspirating smoke detector.

The performance of a single detector sampling from areas at different air pressures (for example, under floor air plenums and room spaces or different rooms in air-conditioned areas) may be affected due to reverse or poor airflow along the sampling pipes.

Piping design considerations for aspirating detectors

It is important that the design does not exceed the number of sampling ports or pipe length of the selected detector. Refer to Table 2 below for details.

Table 2: Detector piping details

Detector	Coverage area (ft.², m²)	Number of pipe inlets	Pipe length per inlet (ft., m)	Total pipe length (ft., m)	Max. sampling ports
One-pipe	2,500 (232)	1	164 (50)	164 (50)	10
Two-pipe	10,000 (929)	2	164 (50)	330 (100)	50
Four-pipe	20,000 (1,858)	4	330 (100)	656 (200)	100

Recommended maximum pipe length

The recommended maximum aggregate pipe lengths for the detectors are provided below. For best system performance, the designer should aim to use several shorter lengths of sampling pipe rather than a single longer length.

- Maximum pipe length = 656 ft. (200 m) - for four-pipe detector
- Maximum pipe length = 330 ft. (100 m) - for two-pipe detector
- Maximum pipe length = 164 ft. (50 m) - for one-pipe detector

As an example, the maximum length of pipe connected to the four inlet ports of a four-pipe detector is 656 ft. (200 m) with a maximum single pipe length of 330 ft. (100 m).

Possible configurations are:

- 4 x 164 ft. (50 m) lengths = 656 ft. (200 m) maximum pipe length
- 3 x 213 ft. (65 m) lengths = 639 ft. (195 m) maximum pipe length
- 2 x 328 ft. (100 m) lengths = 656 ft. (200 m) maximum pipe length

Figure 10 on page 30 shows two illustrations of the same room with sampling holes (detectors) spaced to give the maximum area coverage recommended. Example “A” shows a detector using a single pipe with a total length of 190 ft. (58 m). Example “B” shows a detector using three pipes, the longest being 92 ft. (28 m). Should an incident occur in the position shown, then the time taken for the smoke to travel from the closest sampling hole in design Example “A” would be at least twice as long as from the nearest hole in design Example “B.” PipeCAD modeling shows that the difference is 40 seconds!

The reason for this limitation is that it takes a finite time for the aspirating fan to draw air from the furthest point of the sampling pipes. Using the experience drawn from installations performed when high-sensitivity smoke detection systems were a relatively new technology, performance standards have been devised for the testing of HSSD systems. A range of test procedures has subsequently been devised to suit almost every possible application where HSSD would prove effective.

For all of the tests, except those where large volumes of hot smoke (aerosols) are produced, a period of 120 seconds is allowed after the smoke generation equipment is stopped for the detector to show a response. The time allowed for the smoke generation equipment to operate would be between one and three minutes. Therefore, the total time allowed between the start of the performance test and a definite HSSD system response would be between three and five minutes. The 120 seconds is the allowance for smoke to travel from the most distant sampling hole back to the detector and for the detector to register the smoke. The remainder of the test time period is available for the smoke to reach the sampling hole.

Figure 10: Keeping the sampling pipe lengths as short as possible

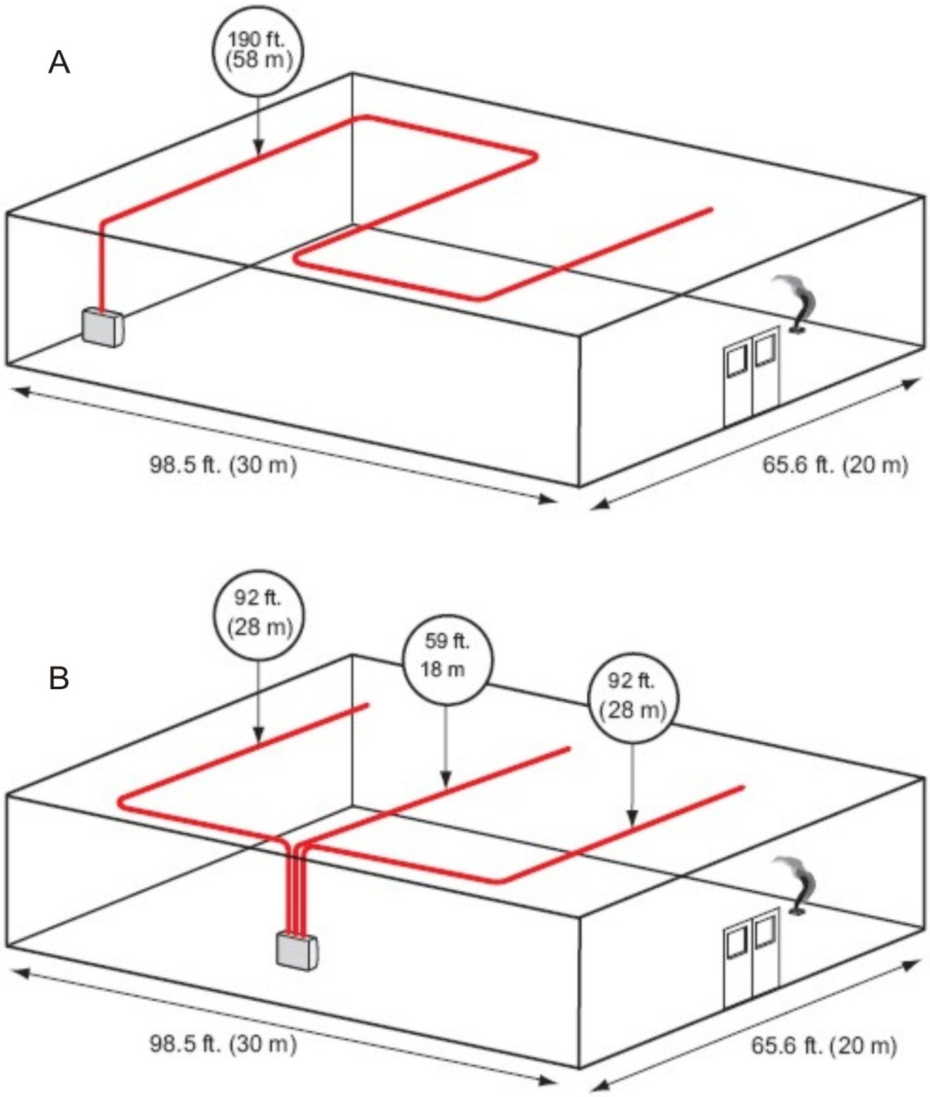
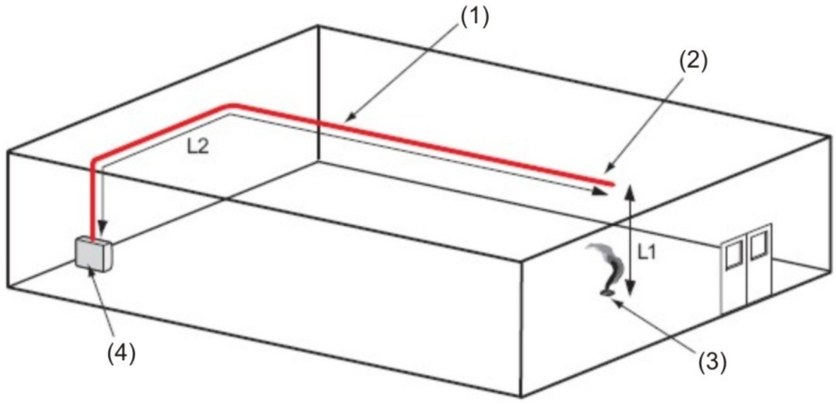


Figure 11 on page 31 shows two distances that must be considered when designing a sampling pipe network. In a typical small room 1,292 ft.^{2} (120 m^2) being monitored by a single detector, the distance between the smoke source and the last sampling hole (L1) is short. Relatively little thermal energy would be required to lift the smoke up to the sampling hole and the time taken for it to travel distance L1 would be brief. As the room is small, the length of the sampling pipe (L2) would also be short and the time between smoke entering the last hole and it being registered by the detector would also be brief.

Figure 11: Distances that affect the performance of an aspirating system



(1) Sampling pipe
(2) Most distant sampling pipe
(3) Smoke source
(4) Detector

Under these circumstances the completed system is likely to pass a fairly stringent performance test, where little smoke and thermal energy are produced.

At the other extreme, consider a system in a warehouse where L1 could be 69 ft. (21 m) and L2 is 328 ft. (100 m) long. The first consideration is how long will it take for aerosols produced during combustion to actually reach the sampling point? It would take an incident with considerable thermal energy to lift the aerosols up to this level. Ventilation within the building may cause the aerosols to dissipate and cool or a thermal inversion level may exist. This is where the temperature of the air may be equal to or greater than that of the aerosols and smoke. At this point, the smoke will stratify and stop rising toward the sampling pipe.

It may take several minutes for the smoke to reach the sampling hole and when it does, it still has to travel a further 328 ft. (100 m) before it can be registered by the detector. This transport could take over an additional 100 seconds and is the only figure that can be assessed by using the PipeCAD software.

Recommended maximum sampling holes

The recommended maximum number of sampling holes for each of the aspirating detectors is provided below.

- Four-pipe detector: 100 sampling hole maximum for 656 ft. (200 m) recommended maximum pipe length
- Two-pipe detector: 50 sampling hole maximum for 330 ft. (100 m) recommended maximum pipe length
- One-pipe detector: 10 sampling hole maximum for 164 ft. (50 m) recommended maximum pipe length

Note: The maximum number of calibrated sampling holes that should be drilled in a single length of sampling pipe is 25.

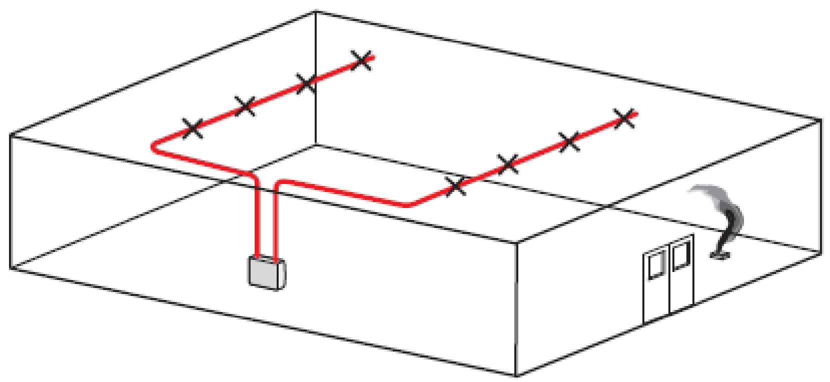
This recommendation ensures that the sensitivity at a single hole should not be less than 1.5% obscuration per foot (5% obscuration per meter). This is equivalent to the sensitivity of an average point-type ionization smoke detector.

The definition of “respond” depends on the source of the document relating to aspirating smoke detectors. For this test, it was understood that a “fire” should have been signaled and the appropriate fire indicator lit. On the four-pipe detector, this output is fixed against the eighth level (Level 8) of the bar graph display (which means the four-pipe detector was able to recognize changes in smoke density of 1/8th of 0.01% obs./ft. [0.05% obs./m] or 0.0063%). The fact that during testing the output of the four-pipe detector went well over twice the capacity of the bar graph display indicates why the four-pipe detector has the potential to detect aerosols that create an obscuration of 0.0001% per ft. (0.003% per meter).

The question of where and how many holes should be drilled is discussed later in this section. The effect of drilling more or fewer holes in the sampling pipe network is discussed in “Understanding basic design principles” on page 28.

Figure 12 below provides an example of an aspirating detector that would generate a “fire” signal when the smoke density in the sampled air reached a value that would cause an obscuration of 0.027 per ft. (0.1% per meter).

Figure 12: Example of a room with eight sampling holes



This room has eight calibrated sampling holes drilled to give a certain area coverage. Assuming smoke enters a single hole, the sensitivity of that hole at the detector would be:

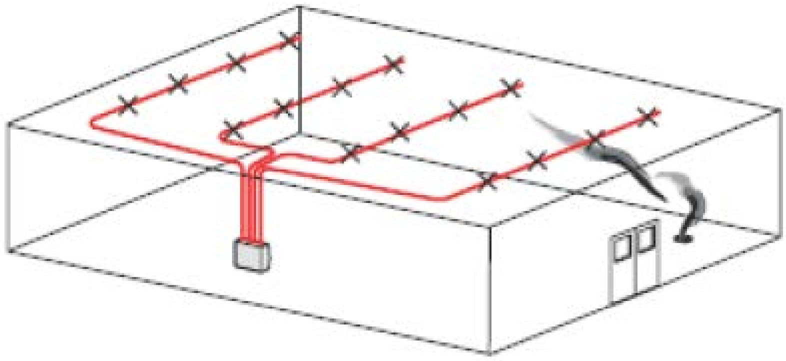
0.027 x 8 = 0.22% obs/ft. (or 0.1 m x 8 = 0.8% obs/m).

If the number of sampling holes was then doubled, the apparent sensitivity of each hole would be halved, that is:

0.027 x 16 = 0.43% obs/ft. (or 0.1 m x 16 = 1.6% obs/m).

This may seem like a disadvantage but while the sensitivity of each hole has been reduced, the likelihood is that smoke will enter more than one hole.

Figure 13: Example of a room with 16 sampling holes



In this example, smoke has entered three sampling holes and the apparent sensitivity is: 0.027 x 16 divided by 3 = 0.14% obs/ft. (or 0.1 m x 16 divided by 3 = 0.53% obs/m).

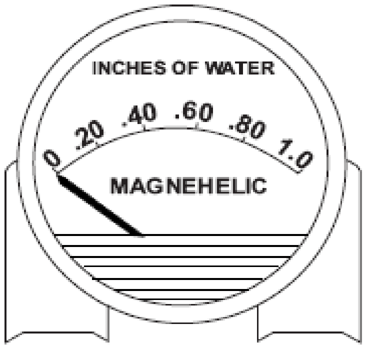
The total system is more sensitive, even though there are more and fewer sensitive sampling holes. However, this is theoretical only. In reality, the density of aerosols rising in a smoke plume or being transported by a mechanical ventilation plant is unlikely to be homogenous. The density will vary moment by moment and the response of the aspirating detector will be to whatever density happens to reach the sampling holes at a particular time. The detector response may not accurately reflect what is actually happening at the source of the smoke and aerosols.

Varying static pressure

An air sampling pipe system and aspirating detector should not be installed in areas where the ambient pressure is positive relative to the ambient pressure surrounding the piping. The exhaust port should be piped to the same area as the sampling network when there is a differential in pressure from where the detector is installed. However, the detector may be installed in an area containing static pressures that are negative with respect to where the piping is installed. One aspirating detector can protect multiple areas of differing static pressures.

Static pressure differential can be measured with a magnehelic pressure gauge, shown in Figure 14 on page 34. To measure differential pressure, connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports. Read the static pressure differential on the gauge, making certain that the magnehelic gauge is held parallel to the floor.

Figure 14: Magnehelic gauge



Detector thresholds and potential sensitivity

The unique ClassiFire artificial intelligence used in our detectors eliminates the need to set detector thresholds that compensate for normal variations in ambient pollution levels. Choosing from a range of known false alarm rates (alarm factors) during the commissioning process allows the detector to begin a learning process about the environment from which it is sampling air. Once it has completed an initial learning phase, it operates at the highest possible sensitivity to maintain the statistical probability of an unwanted alarm. The adjustment of sensitivity is a continually ongoing process. Choosing an alarm factor that offers the greatest possibility of an unwanted alarm (for example, once a year) increases the potential sensitivity of the detector. Choosing an alarm factor that offers the lowest possibility of an unwanted alarm (for example, once in 1,000 years) reduces the potential sensitivity of the detector. For more details and guidance about the ClassiFire feature, see:

- *SenseNET Software User Guide*
- *Remote Control Software User Guide*

Absolute versus relative scaling

Proponents of other smoke detection systems promote the advantage of “absolute scaling.” Far from being an advantage, “absolute scaling” is a major disadvantage. Until the advent of aspirating detectors, the only method of adjusting a high-sensitivity smoke detector to suit its operational environment was to estimate or measure the effects of normal airborne pollution over a period of days. Alarm thresholds were manually set to compensate for this pollution to trigger alarms by abnormal smoke densities. Detectors with absolute scaling (any aspirating system other than ours) are designed so that the smoke level bar graph corresponds to the detector output given by a perfectly clean environment.

There are several problems with this approach:

- The pollution present in most environments results in the detector output bar graph showing the background, or underlying smoke density as a significant proportion of the bar graph.

- The smoke density reading on the bar graph fluctuates as the detector responds to pollution changes in the underlying environment.
- These nuisance alarms cause unwarranted concern to casual observers.

Most environments are subject to fluctuations in underlying smoke and pollution density caused by doors and windows opening, cooking, exhaust fumes, soldering, smoking, and so on.

On a typical installation of an “absolutely” scaled detector, there may be 5% to 30% of its bar graph segments illuminated by “background” smoke, with only 70% of the segments left in which to place the multiple alarm thresholds. The major alarm threshold level is fixed at one of these bar graph levels. The rise in smoke density required to give a major alarm varies with the background level.

There is only one way that a detector with absolute scaling can cope with this variation without having the potential to give unwanted alarms. The system must monitor the protected area and record the variations in the standing levels of normal pollution over an extended period (one year) to determine the maximum long-term detector output and bar graph deflection.

To achieve the highest sensitivity without nuisance alarms, the alarm outputs should be set against the bar graph display at points above the highest recorded level of standing pollution. These points correspond to the desired response from an increase in smoke density from an incipient fire.

Final alarm threshold settings are a matter of judgment on the part of the authorized distributor after having taken the above considerations into account. It may seem that simply setting the alarm level just above the highest level that may normally be expected from the underlying level is the right sensitivity to use. However, what may normally be expected is never assessed with such systems because the underlying level is frequently random in its maximum and minimum levels, even though the average may be reasonably constant.

The question of what are normal variations must be considered. If a high smoke level occurs on average once every week, would the user tolerate a nuisance alarm at the rate of once every week? It is likely that the user would demand that the sensitivity be reduced in order to cure what he considers an unacceptable nuisance alarm situation. The user may tolerate a nuisance alarm at the rate of once every year or more.

How would this frequency be calculated for a fixed sensitivity system in an environment that has variable levels of background pollution? The answer is that for an absolutely scaled detector, it is an impossible task.

Our detectors are the only high-sensitivity aspirating smoke detection systems to apply *relative scaling*. This fundamentally different and patented ClassiFire technology automatically adjusts the detector bar graph so that only pollution greater than the mean (average) levels measured over the preceding hours is indicated on the bar graph. The assessment of the mean level is an automatic and continually updating process. The variation in the underlying signal is also measured and bar graph scaling calculated which is relative to the underlying fluctuations in background pollution and the probability of those fluctuations creating an unwanted alarm. Both these features are integrated into the ClassiFire process, allowing an optimum sensitivity to be set automatically and continuously maintained.

Consider the following scenario:

Take an absolute scaled detector fixed to 0.027% obs/ft. (0.1% obs/m) full scale, 0.0003% obs/ft. (0.01% obs/m) per bar graph segment. Fire alarm level is set at bar graph 8 (0.08% obscuration per meter). The alarm level could be set at any level between 4 and 10, for example. With an underlying room pollution level of 0.0007% obs/ft. (0.02% obs/m), which would be a typical level in most “clean” environments, the absolutely scaled system will show 2 bars illuminated in “normal” operation. If the pollution level were to increase by 50% to 0.006% obs/ft. (0.03% obs/m), then only one more bar would illuminate. To a security guard or other user looking at the display, it would not be immediately obvious that a 50% increase in pollution level had occurred.

When bar graph level 6 is reached, the level is just over halfway between its “normal” reading and alarm. This will not be apparent, though.

By comparison:

Our detector operating in the same environment 0.0007% obs/ft. (0.02% obs/m) (smoke normal density in the protected area) would set the zero on the bar graph to be 0.0007% obs/ft. (0.02% obs/m) absolute in normal operation. No bar graph segments would be illuminated. This makes it obvious that there are no unexpected smoke particles being produced within the area. If this level then increased by 50% to 0.006% obs/ft. (0.03% obs/m), the bar graph would illuminate one segment, alerting a user that there was a potential problem in the protected environment. When bar graph 6 is illuminated, the level is three-quarters of the way between its normal reading and alarm which is apparent (alarm always being at 8).

The authorized distributor permanently sets the sensitivity of an absolute detector when he chooses the positions for the alarm outputs against the various levels of the bar graph as being appropriate for the moment in time the settings are made. After this time, no allowance can be made for changes in the background levels of pollution and the system sensitivity and probability of an unwanted alarm are totally uncontrolled. The authorized distributor sets the sensitivity of the detector by selecting a known probability of a nuisance alarm from one of nine ranges (alarm factors). thereafter, the sensitivity of the detector is continuously adjusted by ClassiFire to maintain this probability of nuisance alarm. If an alarm factor were chosen that had a probability of nuisance alarm of, say, once per year, the sensitivity of the detector would be maintained at a high level. Conversely, should no nuisance alarms be acceptable, an alarm factor giving a probability of, say, once in 1,000 years would be chosen. The sensitivity of the detector would then be automatically maintained at a considerably lower level.

Other major benefits of relative scaling

Most aspirating smoke detectors use particle or dust filters to prevent unwanted dust particles from the sampled air from reaching the detector. As a filter gets contaminated, it actually becomes more efficient and prevents progressively smaller and smaller particles from entering the detector. Eventually, it can stop virtually all smoke particles without noticeably inhibiting the airflow. When an absolutely scaled detector is first installed, it is running at a known sensitivity, typically around 0.0274% obs/ft. (0.1% obs/m). This level of sensitivity is, however, highly dependent on the filter efficiency. For example, if a soiled filter is removing 50% of the smoke, then although the detector “head” was calibrated to 0.0274% obs/ft. (0.1% obs/m) sensitivity, the overall system sensitivity is only 0.055% obs/ft. (0.2% obs/m). The amount of smoke needed to create an alarm has doubled.

The only solution is to regularly change the air filter. As there is no practical method of determining its condition, in many cases it could well be an unnecessary expense. It is a disquieting fact that an “absolutely scaled” detector has no way of compensating for filter degradation. One may think that airflow monitoring could be used to indicate that the filter is becoming blocked. Unfortunately, this is impossible, as the level of particle compaction that affects filter performance is too low for there to be any appreciable reduction in air flowing through the filter medium. Our detectors automatically compensate for filter contamination. As filter contamination causes the mean (average) detector output and the normal variations to reduce, our detector uses historical information from its ClassiFire memory to apply compensation to maintain the original level of performance. This means that filter contamination has negligible effect on system sensitivity. This function is continually monitored and the actual level of compensation can be checked on the integral programmer or via a laptop computer using the software issued with every detector. Therefore, the engineer maintaining the system can replace the filter when appropriate. Once the level of compensation corresponds to 120% of the original signal value, the detector would then be automatically maintained at a considerably lower level.

Calculating system performance with PipeCAD

The final stage in the design process is to predict how the installed system will perform. The use of the PipeCAD pipe modeling software is required to achieve this.

Having entered the relevant information into the modeling software, the designer is able to determine the efficiency of the system design in relation to the performance specification. When evaluating the results of the modeling calculation, the designer should remember the program can only estimate sample transit times within the sampling pipe network itself. The physical characteristics of the protected area and the time taken for any by-products of combustion to reach the network should also be considered when evaluating the results. See “Understanding basic design principles” on page 28 for details.

Having fully evaluated the results of a PipeCAD model, the designer may consider that the proposed sampling pipe network would not meet the performance targets. For example, a network designed using three sampling pipes produces response times that, because of their length, are on the limit of what is considered acceptable, particularly as the area involved is above average height. For this reason, it would be necessary to redesign the sampling pipe network to incorporate a fourth run. This may also involve repositioning the detector.

With the sampling pipe layout design revised to incorporate four shorter runs of pipe, the system should be remodeled on PipeCAD to check the validity of the changes. The most likely result is that the far-end response times will fall significantly and if a larger number of holes is included, the area covered by each sampling hole will be reduced. The overall result is that the revised system will offer more efficient detection and will exceed the minimum acceptable performance requirements.

The PipeCAD modeling program also allows the designer to modify the size or number of sampling holes to increase (or decrease) the general sensitivity of the system in particular regions of the area to be protected. For example, in a general office, there may be one piece of equipment that is considered to be an asset of high risk and high value. By increasing the diameter of the sampling holes protecting this region of the room, a greater proportion of the total air sampled will be drawn from it and will therefore have a proportionally higher overall sensitivity. It should be remembered that the remainder of the sampling holes would have a proportionally lower sensitivity.

Increasing the diameter of the holes is equivalent to drilling a greater number of holes in the same stretch of sampling pipe. This may not always be practical, particularly when using capillary sampling point techniques.

Chapter 4
Installation of piping

Summary

This chapter provides information about the installation of piping.

Content

Introduction

This chapter contains instructions required for a proper installation of a designed pipe sampling network.

CPVC piping installations

Our CPVC air sampling smoke detection pipe products are manufactured from specialty thermoplastics, known chemically as post-chlorinated polyvinyl chloride (CPVC). The CPVC air sampling smoke detection pipe products provide ease of joining, increased hanger spacing in comparison to other plastics, are assembled with readily available, inexpensive tools, and are based on a product with a continuous service history of more than 30 years.

Chemical exposure

Our CPVC air sampling smoke detection pipe products resist attack from a wide range of chemicals that are corrosive to metallic piping; CPVC material has been used in many corrosive industrial piping systems for many years due to its inherent corrosion resistance. However, in instances where a chemical substance may come into contact with the fire sprinkler system, it is recommended that compatibility with CPVC be confirmed by the manufacturer of the product in question prior to use.

Caution: Special care should be taken to avoid the use of or possible contamination of the CPVC pipe and fittings with products containing edible oils, esters, ketones, or petroleum base products such as cutting or packing oils, traditional pipe thread paste or dopes, and some lubricants.

Product handling and storage

Reasonable care should be exercised in handling CPVC air sampling smoke detection pipe products. They must not be dropped or have objects dropped on them. If improper handling results in splits or gouges, the damaged section should be cut out and discarded.

Store these products indoors when possible, in the original packaging, to keep the product free from debris and help reduce the possibility of damage. Do not exceed a maximum storage temperature of 110ºF (43ºC).

The CPVC air sampling smoke detection pipe must be covered with a nontransparent material when stored outdoors. Brief exposure to direct sunlight on the job site may result in color fading, but will not affect physical properties.

Caution: Inspect the product carefully before installation. Do not install product that has visible signs of gouging, splits, or irregularities that may otherwise affect the integrity of the system.

Product ratings and capabilities

CPVC air sampling smoke detection pipe is produced in SDR 13.5 dimensions. SDR, or standard dimensional ratio, means the pipe wall thickness is directly proportional to the outside diameter. Our CPVC air sampling smoke detection pipe is produced to the specifications of ASTM F442. Refer to Table 3 below for recommended pipe dimensions.

Table 3: CPVC air sampling smoke detector pipe dimensions

Normal pipe size	Average OD	Average ID	Pounds per feet
0.75 (20.0)	1.050 (26.7)	0.874 (22.5)	0.168

Thermal expansion

CPVC air sampling smoke detection pipe products, like all piping materials, expand and contract with temperature. The coefficient of linear expansion is 0.0000340 inch/inch ºF (61.2µm/m ºC). A 25ºF change in temperature will cause an expansion of 1/2 in. for a 50 ft. straight length (12.7 mm for a 15.2 m straight length). For most operating and installation conditions, expansion and contraction can be accommodated at changes of direction.

Solvent cementing procedures

The use of Spears FS-5 One-Step Low VOC Solvent Cement or equivalent is recommended to join the pipe and fittings. However, Ipex BM-5 and Thompson Plastics TPI 50 solvent cements can also be used, provided that the assembly and curing instructions referenced in this manual are used. The One-Step process eliminates the need for the primer application, as the cement itself provides adequate softening of the joining surfaces. This joining method simplifies installation by reducing labor and offers faster curing times prior to system operation in most cases.

Note: Follow appropriate cure times for the solvent cement chosen.

Cutting

CPVC air sampling smoke detection pipe can be easily cut with a wheel-type plastic tubing cutter, pipe ratchet cutter, a power saw, or a fine-toothed saw. Care must be taken not to split the pipe if a ratchet-type cutter is used, especially in temperatures below 50ºF (10ºC). If any indication of damage or cracking is evident, cut off at least 2 in. (51 mm) beyond any visible crack.

It is important that the cutting tools used are designed for use on plastic pipe. To make sure that the pipe is cut square, a miter box must be used when using a saw. Cutting the pipe as squarely as possible provides the surface of the pipe with a maximum bonding area.

Figure 15: Using the appropriate pipe cutting tools

Deburring and reaming

Burrs and filings can prevent contact between pipe and fitting during assembly, and must be removed from the outside and the inside of the pipe. A chamfering tool or file is suitable for this purpose. A slight bevel should be placed at the end of the pipe to ease entry of the pipe into the socket and minimize the chances of wiping solvent cement from the fitting.

Figure 16: Removing burrs and filings from outside and inside of the pipe

Fitting preparation

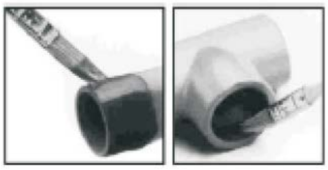
Using a clean, dry rag, wipe loose dirt and moisture from the fitting socket and pipe end. Moisture can slow the cure time, and at this stage of assembly, excessive water can reduce joint strength. Prior to assembly, all piping system components should be inspected for damage or irregularities. Mating components should be checked to assure that tolerances and engagements are compatible. Do not use any components that appear irregular or do not fit properly. Contact the appropriate manufacturer of the component product in question to determine usability. Check the dry fit of the pipe and fitting. The pipe should enter the fitting socket easily, 25% to 75% of the way. If the pipe bottoms in the fitting with little interference, use extra solvent cement in making the joint.

WARNING: Before applying cement, appropriate safety precautions should be taken. Cement should be stored in the shade between 40ºF (4ºC) and 110ºF (43.3ºC). Eliminate all ignition sources. Avoid breathing vapors. Use only with adequate ventilation; explosion-proof general mechanical ventilation or local exhaust is recommended to maintain vapor concentrations below recommended exposure limits. In confined or partially enclosed areas, an appropriate OSHA-approved breathing apparatus is recommended. Containers should be kept tightly closed when not in use, and covered as much as possible when in use. Avoid frequent contact with skin; wearing PVA coated protective gloves and an impervious apron are recommended. Avoid any contact with eyes; splash-proof chemical goggles are recommended. (Please refer to GENERAL SAFETY MATERIAL SAFETY DATA SHEETS for SPEARS CPVC One-Step FS-5 or equivalent cement. Verify expiration dates stamped on cement can prior to use.)

Solvent cement application

The solvent cement should be applied when the pipe and fittings are clean and free of any dirt, moisture, or debris. Spears CPVC One-Step solvent cement FS-5 or equivalent should be worked into the joining surfaces with an applicator or natural bristle brush at least 1/2 the size of the pipe diameter. Apply a heavy, even coat of cement to the outside pipe end. Apply a medium coat to the fitting socket. A second application of cement should be applied to the pipe end if there was little interference when the dry fit was checked.

Figure 17: Applying solvent cement with a natural bristle brush



Assembly

Immediately insert the pipe into the fitting socket while rotating the pipe 1/4 turn. Properly align the fitting for the installation at this time. Pipe must bottom to the fitting stop. Hold the assembly for 10 to 15 seconds to ensure initial bonding. A bead of cement should be evident around the pipe and fitting juncture. If this bead is not continuous around the socket shoulder, it may indicate that insufficient cement was applied. If insufficient cement is applied, the joint must be cut out, discarded, and begun again. Cement in excess of the bead can be wiped off with a rag.

Figure 18: Inserting the pipe into the fitting socket (rotate the pipe 1/4 turn)

CPVC solvent cement set and cure times are a function of: the cement type used, pipe size, temperature, relative humidity, and tightness of fit. Drying time is faster for drier environments, smaller pipe sizes, high temperatures and tighter fits. The assembly must be allowed to set, without any stress on the joint, for 1 to 5 minutes depending on the pipe size and temperature. Following the initial set period the assembly can be handled carefully avoiding stresses to the joint. Refer to Table 4 below for minimum cure times prior to system operation.

Figure 19: The assembly must be allowed to set without any stress on the joint

Table 4: Recommended cure prior to system operation

Pipe size (inches)	Ambient temperature during cure		
3/4	60° to 120° F (16° to 49° C)	40° to 59° F (4° to 15° C)	0° to 39° F (-18° to 4° C)
	15 minutes	15 minutes	30 minutes

WARNING: Installers should verify for themselves that they can make satisfactory joints under varying conditions and should receive training in installation and safety procedures. Consult the material safety data sheets and ASTM F-402, Standard Practice for Safe Handling of Solvent Cements and Primers.

Installers should verify for themselves that they can make satisfactory joints under varying conditions and should receive training in installation and safety procedures. Consult installation instructions, material safety data sheets and ASTM F-402, *Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings*.

Caution: Avoid puddling of cement on or within fitting and pipe, which causes excess softening of the material, and could cause damage to the product.

Note: Use of solvent products other than those recommended by the manufacturer automatically voids the warranty on the pipe and fittings.

Hangers and supports

Because CPVC air sampling smoke detection pipe is rigid, it requires fewer supports than flexible plastic systems. Vertical runs must be supported so as not to place the weight of the run on a fitting or joint. Horizontal runs must be braced so that stress loads (caused by bending or snaking the pipe) is not placed on a fitting or joint.

Table 5 below shows recommended support spacing.

Sampling pipe must be supported at every change in direction, before and after wall penetration and in accordance with the spacing shown in Table 5 below.

Table 5: Recommended support for piping system

Nominal pipe size		Maximum support spacing	
Inches	**Millimeters**	**Feet**	**Meters**
3/4	20	5.5	1.7

Some hangers designed for metal pipe may support the CPVC air sampling smoke detection pipe, but their suitability must be clearly established. The pipe hanger must have a load-bearing surface of at least 1/2 in. (13 mm). Hangers with sufficient load bearing surface must be selected based on pipe size (i.e., 3/4 in. hangers for 3/4 in. pipe). The hanger must not have rough or sharp edges which come in contact with the pipe. Hangers must not be of a type which binds the pipe from movement.

Pipe hangers are available that have been designed and tested for use with CPVC plastic only, and are UL Listed for this purpose. These products incorporate special features which are designed to protect the pipe and make installation easier. The patented flared-edge design protects the pipe from coming in contact with any rough or sharp surface. The hex head self threading screw (furnished with the product) is easily installed using a cordless electric drill and socket attachment. No predrilling of a pilot hole in wood is required.

WARNING: It is the responsibility of the installer to determine a suitable hanger and/or support that meets the requirements for the specific application. Failure to utilize the appropriate method may jeopardize system integrity and subject the installation to potential harm.

Examples of UL Listed hangers and supports

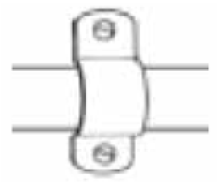
Note: For UL installation of exposed CPVC air sampling smoke detection pipe, UL Listed support devices for thermoplastic sprinkler piping or other UL Listed support devices must be used to mount the piping directly to the ceiling or sidewall.

Single fastener: The illustration below shows a single fastener which can function as a hanger or as a restraining device by inverting the hanger and installing with the fastener mounting tab downward.

Figure 20: Single fastener

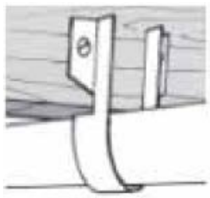
Double fastener: The illustration below shows a double fastener which can function as a hanger and a hold-down strap.

Figure 21: Double fastener



Mounted hanger/restrainer: The illustration below shows a fastener which can function as a hanger or as a restrainer and can be mounted from the top or bottom of a beam. The fastener mounting edges are designed to allow the screws to be installed horizontally. This is a benefit when overhead clearance is limited.

Figure 22: Hanger or restrainer mounted from a beam



Band hanger/restrainer: The illustration below shows a fastener which functions as both a hanger and restrainer. This easily installed combination restricts the upward movement of the pipe while not allowing the threaded support rod to contact the pipe.

Figure 23: Band hanger or restrainer

Recommended method for securing CPVC sample pipe vertically

- Vertical piping must be supported at intervals to avoid placing excessive load on a fitting at the lower end. Do this by using riser clamps or double bolt pipe clamps.
- The clamps must not exert compressive stresses on the pipe. If possible, the clamps should be located just below a fitting so that the shoulder of the fitting rests against the clamp. If necessary, a coupling can be modified and adhered to the pipe as a bearing support, so that the shoulder of the fitting rests on the clamp.
- Do not use riser clamps that squeeze the pipe and depend on compression of the pipe to support the weight.
- Hangers and straps must not compress, distort, cut, or abrade the piping and must allow for free movement of the pipe to allow for thermal expansion and contraction.
- Maintain vertical piping in straight alignment with supports at each floor level, or at 10 ft. (3.05 m) intervals, whichever is less.
- CPVC risers in vertical shafts or in buildings with ceilings over 25 ft. (7.62 m) should be aligned straightly and supported at each floor level, or at 10 ft. (3.05 m) intervals, whichever is less.

Design criteria

Caution: When drilling holes in solid wood joists and in studs (wood or metal) to route the pipe, structural integrity must be maintained. Consult the authority having jurisdiction (AHJ) or building code for requirements. When routing pipe through metal studs, holes drilled must be oversized to allow for movement caused by expansion and contraction. Care must be taken to ensure that the pipe is not in contact with the metal stud or damaged by contact with rough or sharp edges. This can be accomplished by the use of plastic grommets or other suitable protection of the pipe in this area. The pipe must be independently supported at specified intervals by the use of a suitable hanger with sufficient load-bearing surface.

Penetrating fire-rated walls and partitions

Before penetrating fire-rated walls and partitions, consult building codes and authorities having jurisdiction in your area. Several UL classified through-penetration fire stop systems are approved for use with CPVC pipe. Major building codes require that a fire resistant wall or floor must be sealed back to its original integrity when penetrated. Plans must show how the penetration will be fire-stopped to obtain approval from the authority having jurisdiction.

Several sealants and materials are suitable for use with CPVC air sampling smoke detection pipe when installed per the manufacturer's instructions and constructed in conjunction with the appropriate UL penetration system. When installed correctly, these systems will provide a two-hour fire rating. The UL Building Directory, UL Fire Resistance Directory, and the sealant manufacturer should be consulted for proper selection, installation, and construction techniques.

Earthquake bracing

Since PVC air sampling smoke detection pipe plastic is more flexible than metallic pipe, it has a greater capacity to withstand earthquake damage. In areas subject to earthquakes, air sampling pipe systems should be designed and braced in accordance with local codes and standards.

Recommended cut-in procedures

Caution: Prior to making system cut-ins on existing systems, care should be used to review proper joining procedures and to follow set and cure times to ensure the highest system integrity.

Several methods can be utilized to tie into an existing system using a socket style tee fitting in combination with the use of socket couplings and unions. Regardless of the method used, the following points must be followed to ensure the highest integrity:

- Using proper tools, the cut-in should be made on the smallest diameter pipe section (that is capable of adequately supplying the system changes) in close proximity to the modification being made. This approach expedites cure times prior to system operation.
- The cut-in connection to the existing system should be made first, prior to proceeding with additional work.
- Carefully review and follow solvent cementing procedures for proper joining techniques prior to commencing with cut-in (pipe must be cut square to proper length, deburred, beveled, and dry, to ensure proper insertion depth and highest integrity).
- Carefully measure and cut pipe to proper length to ensure complete insertion during assembly (check the dry fit of the components being joined).

- During assembly of the cut-in tee (and other components), it is important to make the 1/4-turn when inserting the pipe into the fitting. This may require the use of several components assembled in combination with the cut-in tee to create a short spool piece assembly. This can be accomplished by using socket unions or couplings to ensure that a 1/4-turn can be obtained on all pipe connections being joined.
- Prior to applying solvent cement, use a clean dry rag to wipe moisture and dirt from the fitting socket and the pipe end (the presence of moisture on the joining surfaces reduces joint integrity).
- Use a new can of cement when making cut-in connections. Verify expiration dates stamped on can prior to use.
- After all work is completed; the cut-in joints must be allowed to cure properly prior to system operation according to the minimum cure times shown in Table 4 on page 44.

Pipework

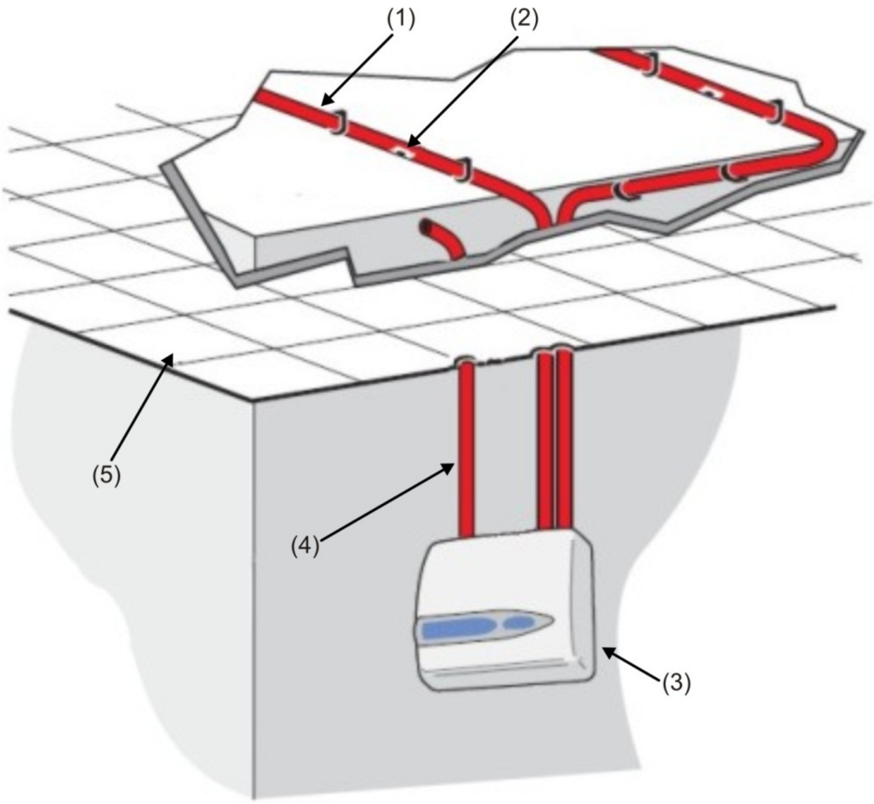
Pipework should follow these guidelines:

- Sampling pipes should be made from a nonhazardous material and should be clearly identified.
- The ideal internal diameter of sampling pipes is 3/4 in. (20 mm). Other sizes will often work but will provide different response times.
- Ideally, if the total length of sampling pipe is greater than 164 ft. (50 m), then multiple pipes should be used. When using multiple sampling pipes, care should be taken to achieve a reasonable degree of balance (say within 10% of airflow) to ensure even suction from the pipes.
- Maximum recommended total sampling pipe lengths are listed below:
    - Maximum pipe length = 200 m (656 ft.) - for four-pipe detector
    - Maximum pipe length = 100 m (330 ft.) - for two-pipe detector
    - Maximum pipe length = 50 m (164 ft.) - for one-pipe detector
- Sampling pipes must have capped ends. The end cap should be drilled with a sampling hole normally between 0.16 in. to 0.20 in. (4 to 5 mm) in diameter and free from burrs.
- Sampling holes should normally be 0.12 in. to 0.16 in. (3 to 4 mm) in diameter or as calculated by PipeCAD, and free from burrs. A pipe run should not have more than 25 holes. When drilling holes in the sampling pipes or cutting off lengths of pipe, ensure that all grinding and debris is removed from the pipe. Ensure that all sampling holes are free from burrs.
- The calculated pipe transit time should not exceed 120 seconds.
- The manufacturer recommends the use of the 3/4 in., smooth bore, UL listed CPVC pipe or the 3/4 in. ABS pipe for freezer applications.

This guide holds true for average sampling pipe lengths, but if using long pipes — typically more than 197 ft. (60 m) total — performance may be improved by making the sampling holes near the ends slightly larger than those nearer the detector.

As required by NFPA-72, PipeCAD pipe modeling software is to be used to ensure that transit times, balance of suction, and individual sampling are within desired limits.

Figure 24: Locating the detector outside the protected area



(1) Sampling pipe
(2) Sampling hole
(3) Detector
(4) Exhaust pipe
(5) False ceiling

Drilling and calibrating sample holes in pipe

Hydraulic flow calculations for determining appropriate sample port hole sizes, validating hole sensitivity, and system transport times must be calculated using the most current version of PipeCAD modeling software and for UL installations must be made according to NFPA standards applicable to air sampling smoke detection systems.

Sampling holes of the correct diameter (based on results from PipeCAD) should be drilled in the positions marked on the design drawings. If significant deviations from the original sampling pipe network design were necessary during installation, revised PipeCAD models must be produced that illustrate the changes and confirm that the system continues to meet the design specifications, listings, and jurisdictional codes and standards.

WARNING: It is imperative that the installer wears proper eye and ear protection and follows all job site safety rules.

To drill and calibrate sampling holes in the pipe, you need the following tools.

- Cordless or plug-in power drill
- Good quality drill bits from 5/64 through 1/4 in.
- Eye protection
- Ear protection
- Accurate set of plans or drawings
- Results from PipeCAD modeling software
- Vacuum
- Deburring tool or reamer

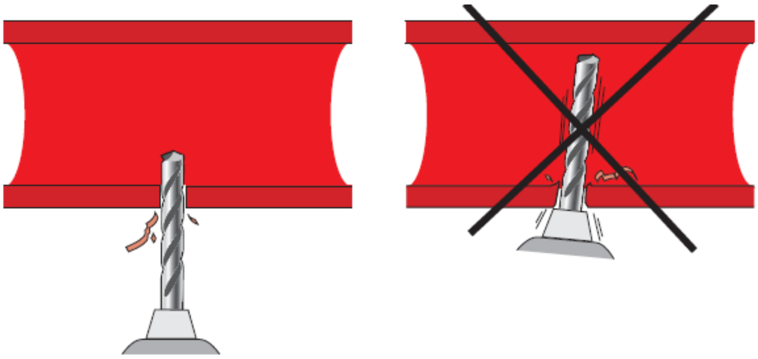
For complex or unbalanced sampling pipe networks, the designer may use features in PipeCAD that calculate the calibration of sampling hole diameters in 1/64 in. steps. The installer should have a set of good quality drill bits between 5/64 and 1/4 in. in diameter.

Care should be taken, particularly if sampling holes are being drilled simultaneously with the erection of the sampling pipe, that the correct diameter hole is drilled against the drawing coordinates.

The holes should be drilled at low speed with minimum force and at a right angle.

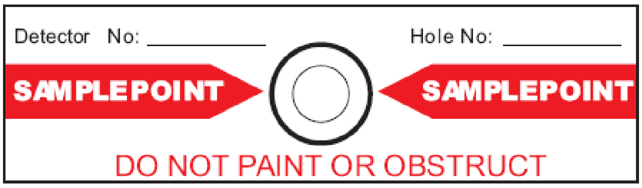
Caution: Using a blunt drill and forcing it into the pipe at high speed will throw debris into the sampling pipe and cause internal burrs, which may result in disruptions. Carelessly drilled holes, particularly in small diameters, can seriously affect the overall response of a system and may ultimately cause a system to fail inspection.

Figure 25: Careful drilling of sampling holes ensures correct flow



As an aid to locating and identifying sampling points, a label should surround each point. A suitable label is shown in the illustration below.

Figure 26: Sampling hole identification label



Make sure that holes are clean from burrs by using a deburring tool where necessary.

As drilling holes creates debris within the pipe and the surrounding workplace, make sure that all debris is removed from the pipe section by either shaking the pipe vertically (if drilling sample points prior to installing the pipe section) or by using a shop vacuum sufficiently sized to flush the pipe network prior to system operation. This is usually done by inserting the nozzle of a shop vacuum into the end of the sample pipe where it is intended to enter the detector inlet. Make sure that the pipe network end caps are not in place when performing this task to ensure sufficient flushing of the pipe network. Make sure that the surrounding workspace is cleared from any debris.

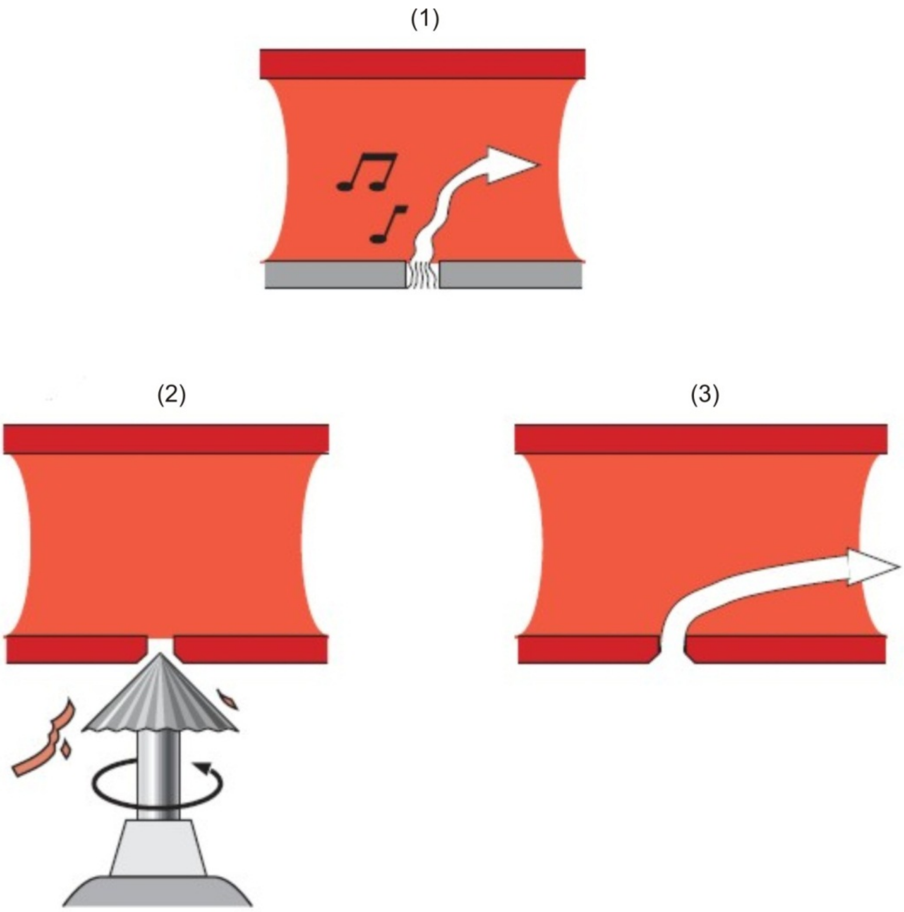
Noisy sampling ports

Occasionally, one or more of the sampling holes may “whistle.” The causes of this phenomenon are functions of the air density, relative humidity, air velocity, and the shape of the sampling hole itself.

Little can be done about air density and relative humidity, so a possible resolution lies with the shape of the sampling hole and the air velocity through it. The whistle is caused by the sampled air being drawn over the sharp edges of the hole with sufficient velocity to make it resonate. This condition may affect system performance if not remedied.

A common and effective approach to remedy this condition is to countersink the inlet to the hole. This smoothes the airflow and reduces the depth of the hole itself. Care should be taken to not increase the actual hole diameter itself but just to remove the sharp edges surrounding the hole.

Figure 27: Correcting a noisy sampling port



(1) Noisy sampling hole - poor flow

(2) Countersink the hole

(3) No noise - correct flow

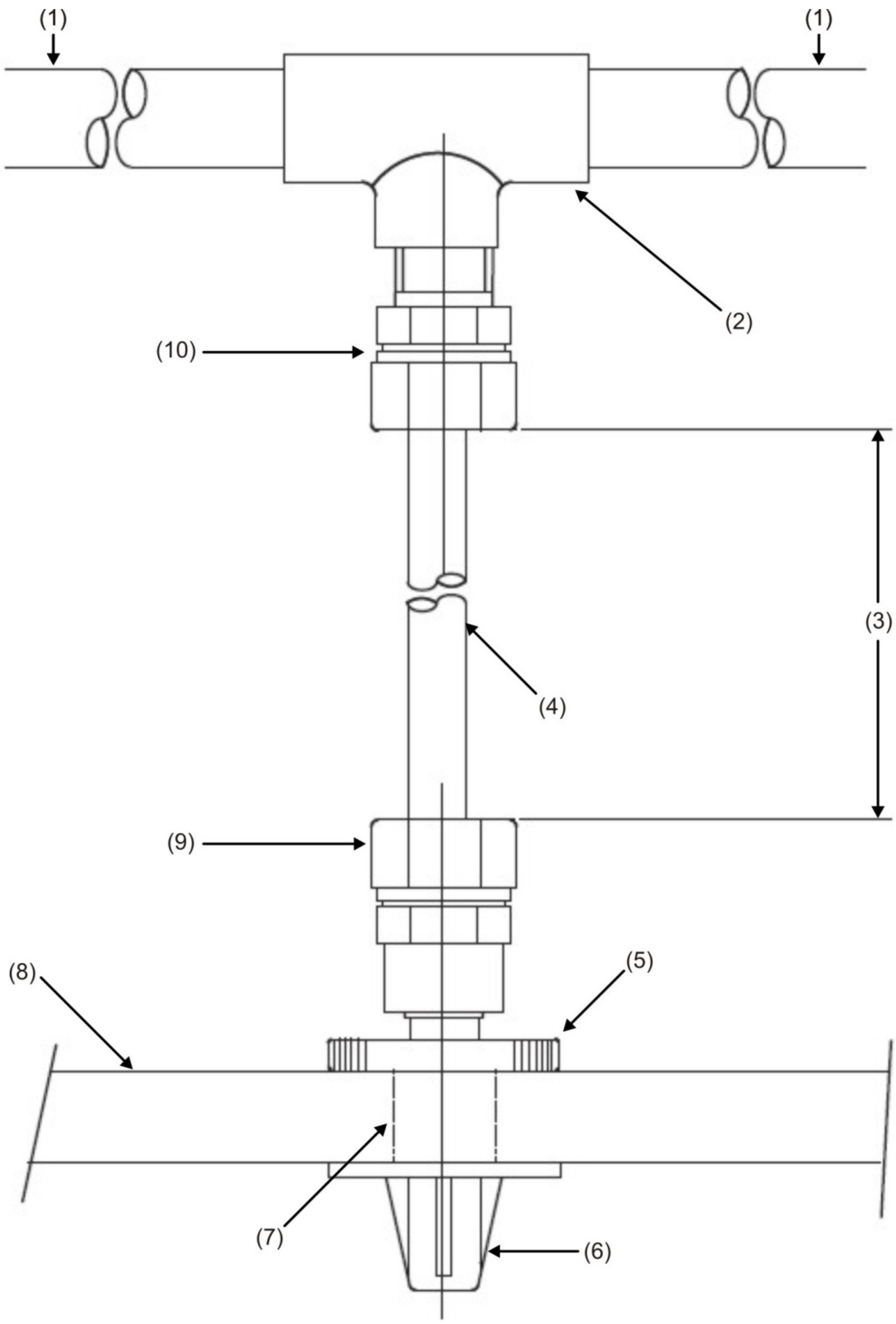
Installation of other sampling methods

The standard pipe sampling method, locating sampling holes strategically in a distribution network, is a typical type of installation. The installation procedures covered in the following sections discuss other typical sampling methods.

Capillary sampling installation

Capillary tube sampling points are drop-down points in the pipe network which consist of a tee, male 1/2 in. NPT capillary tube adapter, female 3/8 in. NPT capillary tube adapter, 3/8 in. capillary tubing, and sampling point. The sampling hole must be drilled into the sampling point.

Figure 28: Capillary sampling point kit



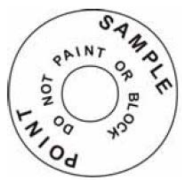
(1) Pipe network
(2) 3/4 x 1/2 in. or 1/2 x 1/2 in. T fitting
(3) 12 ft. (3.66 m) maximum
(4) Capillary tube
(5) Sample point thumb screw nut
(6) Sample point
(7) 7/8 in. hole
(8) Ceiling tile or mounting surface
(9) Female capillary tube adapter (1/2 in. OD compression x 3/8 in. NPT)
(10) Male capillary tube adapter (1/2 in. OD compression x 1/2 in. NPT)

The sampling point is made of a flame-retardant, self-extinguishing plastic. It is also UV stabilized to inhibit yellowing over time. The capillary tubing is tested for use in plenum areas. The tubing is also flame-retardant.

To install a capillary tube sampling point:

1. Verify that a T fitting has been installed into the pipe network at the location where you want to place a sampling point.
2. Drill or punch a 7/8 in. hole into the ceiling tile or other surface.
3. Insert the sampling point, thread end first, into hole until sampling point is flush with surface.
4. Install the thumbscrew onto the sample point threads; tighten until snug.
5. Install and tighten the male capillary tube adapter to the T fitting.
6. Place the capillary tubing onto the male capillary tube adapter. Cut the tubing to the desired size.
7. Place the sized tubing into the male connector and tighten the compression nut.
8. Place the tubing into the female capillary tube adapter. Insert the female capillary tube adapter onto the sampling point thread and tighten it while using a wrench to prevent the sampling point from rotating.
9. Use a wrench to tighten the female capillary tube adapter to the nut.
10. Apply a label to identify the sampling point. See Figure 29 below.

Figure 29: Capillary sampling point label



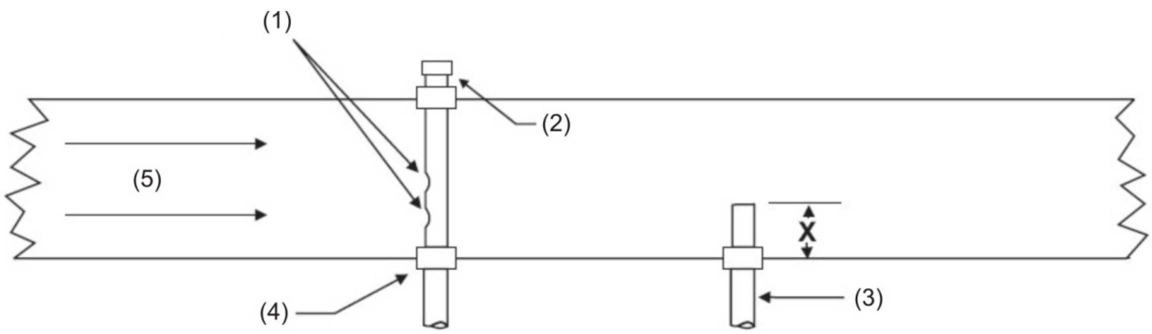
Return air duct sampling installation

The following duct sampling pipe requirements should be noted:

- The intake sampling tube must face into the airflow.
- The intake sampling tube must go through the duct and be closed-ended (capped).
- Holes in the sampling tube must be spaced approximately every 4 in. (100 mm).
- The exhaust tube must extend a minimum of 2 in. (60 mm) into the duct.
- The total pipe network, including the return, must not exceed maximum pipe length of the chosen detector.
- Intake and exhaust tubes should be UL category QNVT rated for return air plenums.

Refer to Figure 30 on page 56 for an overview of the return air duct sampling method.

Figure 30: Return air duct sampling method



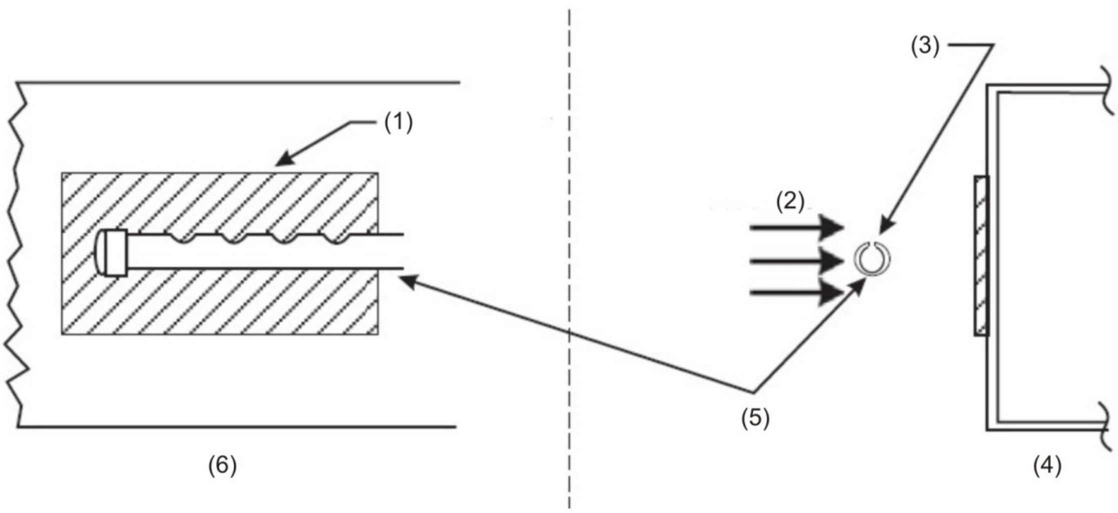
(1) Calculated sampling holes facing airflow spaced every 4 in. (10.2 cm)
(2) Closed end cap
(3) Exhaust tube (dimension X must extend 2 in. (5.1 cm) minimum into the duct
(4) Airtight rubber grommet or equivalent
(5) Airflow

Return air grill sampling installation

Return air grill sampling systems are designed with sampling pipes centered in the front of the return air grill. Sampling holes should be spaced so that a minimum of three holes is used for each grill. Larger grills require more sampling holes. The sampling holes should be at 90 degrees to the airflow with a closed-end pipe (capped).

Refer to Figure 31 below for an overview of the air grill sampling method.

Figure 31: Air grill sampling method



(1) Return air grill
(2) Airflow
(3) Sampling holes face 90 degree to the airflow
(4) Side view
(5) Sampling pipe centered on grill
(6) Front view

Review of recommended pipe installation practices

The points listed below provide a summary of the most important guidelines to bear in mind before beginning sampling pipe installation:

- Always wear eye and ear protection and follow all job-site safety requirements.
- Always use tools specifically designed for plastic pipe and fittings.
- PVA-coated protective gloves are recommended for use while solvent cementing. If your hands come in contact with solvent cement, use a waterless abrasive soap.
- When solvent cementing, avoid sources of heat or open flames and do not smoke.
- Always chamfer and deburr pipe ends.
- When applying cement, prevent excessive solvents from running into the pipe or fitting socket.
- When bottoming a joint, rotate the pipe 1/4 turn. If a specific alignment is required, dry mark the pipe or use quarter marks on fittings. Refer to “Recommended cut-in procedures” on page 48.
- Do not bend or twist an air sampling smoke detection pipe system before waiting for the recommended cure times.
- Keep in mind that the piping materials expand and contract with changes in temperature.

Chapter 5
System commissioning

Summary

This chapter covers the commissioning procedures for the air sampling pipe system and detectors.

Content

Introduction

This chapter covers the commissioning procedures for the air sampling pipe system and detectors. Commissioning results should be recorded on the commissioning check sheet.

Commissioning

The commissioning check sheet should be completed upon commissioning of every air sampling pipe system and detector. The purpose of this sheet is to document proper system operation and acceptance by the owner, to provide reference data for future testing and maintenance of the system, and to register serial numbers for warranty. Completed and signed copies of the commissioning check sheets should be distributed as directed on the sheet.

Precommissioning preparation

After the air sampling pipe system and detector have been completely installed, they must be inspected and tested and all configuration and ambient conditions can be recorded.

Before starting the commissioning tests, go through the following precommissioning preparation steps:

1. Perform a visual inspection of all air sampling pipe system and detector hardware. Check that all system equipment has been mounted properly and wired correctly.
2. Leave all detectors in operation for a period of time to allow the remaining particulate matter that may have been left during installation in the pipe network and/or ducts to clear out of the system.
3. Check that all detectors in the system are cleared of all trouble conditions.
4. Isolate all detectors or disconnect all alarm and trouble circuits to prevent communication of alarms and troubles to ancillary equipment.

Commissioning is recommended after all construction has been completed and the area cleaned of any lingering post-construction dirt. If ambient monitoring conditions are recorded before the installation is cleaned up, they may not accurately reflect actual normal operating conditions that must be used as reference data for follow-up maintenance procedures and tests.

Ambient monitoring

Ambient monitoring should be recorded for a recommended time period of at least one week during normal operating conditions. All air handling units, thermostats, and other systems that can have an effect on the operating environment should be turned on to simulate normal operating conditions as closely as possible.

Airflow test

The detector airflow monitoring should be tested using a high airflow test. Use the following procedure to verify the high airflow fault operation:

1. Increase the airflow to the detector by opening the pipe.
2. Allow up to 60 seconds plus airflow delay time for a trouble to activate.
3. Record the test result on the commissioning check sheet.
4. Reattach the pipe to return the detector back to normal operating mode.

Transport time verification

A maximum transport time verification test is the measure of the amount of time it takes for the detector to respond to smoke that enters the pipe at the sampling point farthest from the detector. The results of this test should be recorded on the commissioning check sheet. A measured transport time of less than 120 seconds is acceptable.

To measure the maximum transport time of the system:

1. Determine the farthest sampling point from the detector.
2. Allow test smoke to enter the pipe at the farthest sampling point.
3. Record the amount of time required for the detector to respond. This is the actual maximum transport time. This time must be less than 120 seconds to meet the requirements of NFPA.

Gross smoke testing

The gross smoke test is a measurement of the amount of time elapsing from the activation of the smoke generating medium, until PreAlarm and Alarm states are reached. This test should be repeated at least three times with consistent results. The recommended smoke generating medium is aerosol simulated smoke or a wire burner.

Aerosol smoke spray

There are a number of commercially available aerosol smoke sprays or “canned smoke.” Refer to your supplier for a recommended product. When using canned smoke, introduce only enough smoke into the protected area to cause an Alarm condition. This may require a number of practice sprays. Follow manufacturer’s instructions.

Caution: Oil-based canisters that are used to test point detectors are not suitable for testing aspirating systems, as the particulate is heavy and tends to drop out in the pipe, never actually reaching the detector. Also, the oily residue that is left behind may affect the functionality of the detector.

Wire burner tests

The wire burner test is considered the most representative test of incipient fire hazard detection in telecommunications or computer room environments. The test is performed by applying a voltage to a piece of PVC-insulated cable. Smoke is produced from the overheated PVC insulation by evaporation and condensation of the plasticizer. As the wire becomes hotter, hydrogen chloride (HCl) gas is emitted from the insulation. The byproducts of overheated PVC insulation can be detected by the detector.

Wire burner Test 1 (optional)

The following test is considered unlikely to produce hydrochloric acid vapor. This test may be undertaken in underfloor spaces or ceiling voids.

1. Connect a 6.5 ft. (2 m) length of wire to a 6 VAC source of at least 16 A rating per wire for a period of 3 minutes.
2. The system should respond within 120 seconds of cessation of energization. After this period, very little smoke is given off.

Notes

- The wire is subject to cooling if positioned in direct contact with airflows and may need to be shielded.
- The wire should be 10 AWG with the following diameter and area:
  Diameter = 2.59 mm or 0.10189 in.
  Cross-section area = 5.0 mm^2 or 0.00775 in.^{2}

Wire burner Test 2 (optional)

WARNING: The following test is considered to produce sufficiently high temperature to generate small quantities of hydrogen chloride or hydrochloric acid gas. Be sure to keep a safe distance away while voltage is being applied.

Caution: A wire burner/canned smoke test could activate spot-type detectors.

This test may be undertaken in underfloor spaces or ceiling voids where rapid airflow may render Test 1 unsuitable.

1. Connect a 3.25 ft. (1 m) length of wire to a 6 VAC source of at least 16 A rating per wire for a period of 1 minute.
2. The system should respond within 120 seconds of cessation of energization. After this period, most of the insulation should be burned off.

Note: The wire should be 10 AWG with the following diameter and area:
Diameter = 2.59 mm or 0.10189 in.
Cross-section area = 5.0 mm^2 or 0.00775 $in.^2$

Chapter 6
Introduction to PipeCAD

Summary

This chapter provides general information about the PipeCAD program.

Content

Introduction

PipeCAD is a Windows application that is used for designing air sampling pipe networks for use with aspirating high sensitivity smoke detectors (HSSD).

The overall performance of an HSSD system depends on proper layout and design of the air sampling pipe network. Optimal performance can be achieved by designing a balanced pipe network using PipeCAD. A balanced pipe network is defined as having equal sensitivity at each sampling hole.

PipeCAD designs a dynamically balanced pipe network by calculating the suction pressure of each sampling point in the pipe network. PipeCAD then calculates each sample hole diameter in order to equalize the suction pressure for the entire network. PipeCAD also provides a variety of calculations such as maximum transport time of the pipe network and optimal pipe diameters.

PipeCAD assists in the design of a pipe network with its isometric drawing capability. A designer can “sketch” the network using a variety of buttons that represent piping, sample holes, capillaries, etc. This “sketch” allows the designer to easily visualize the pipe network. Pipe networks can be designed with a wide variety of pipe types and pipe fittings and various reports can be generated for commissioning and purchasing purposes.

Features

PipeCAD lets you visualize sampling pipe layouts on-screen and offers the following features:

- Layouts can be entered in plan (two-dimensional) or isometric (three-dimensional) representations with the easy-to-use graphical user interface.
- PipeCAD directly supports loading of CAD-generated room or entire building drawings from DXF files. The DXF file format is supported by most popular CAD packages, including AutoCAD.
- Pipe layouts created in PipeCAD can be imported into other programs to help create complete site documentation.
- PipeCAD calculates sampling point airflow rates, the balance between holes and pipes (when multiple pipes are used), and sampling point sensitivity.
- A designer can view estimated sensitivity and smoke transport time for each sampling pipe.
- Extensive hole size optimization routines enable PipeCAD to balance the flow rates through the holes to ensure consistent hole sensitivity along the entire pipe run. PipeCAD can automatically increase the hole sizes to get within a specified transit time.
- Placement and sizing of sampling holes is automatically performed by PipeCAD.

- A designer can see the effect of changing detector type, aspirator speed, and hole quantity and size on system performance before finalizing the design.
- An automatically-generated *bill of materials* gives the quantities, part numbers, and prices (if entered) of all pipe components used to make up a sampling pipe layout. You can configure prices to reflect the current pricing levels of your company.
- PipeCAD supports NIST's Fire Dynamics Simulator, allowing the complete system response time to be modeled.
- Help files give many application examples covering air handling units, duct sampling, condensation traps (for humid areas), and more.

Considerations

The following must be considered when designing a pipework system in PipeCAD:

- The results provided by the program are only as reliable as the data entered by the designer. The accuracy of predicted smoke transport times depends upon the accuracy of the pipe length data supplied and the accuracy of the sampling hole diameters.
- Estimated smoke transport time is the time taken for smoke to travel from a sampling hole to the detector. Allowance must be made for the time taken for smoke to reach the sampling hole.
- PipeCAD software is intended as a guide for designers. The software is unable to compensate for all influences on the flow of sampled air, such as negative pressure acting upon the sampling holes.

Caution: The data supplied by the PipeCAD program is no substitute for *thorough* smoke testing on the *actual installed system.*

Getting started

Before beginning to use PipeCAD, become familiar with the Windows environment, common Windows procedures, and HSSD design criteria and limitations.

A review of the detector manuals is necessary for the proper design of systems.

System requirements

PipeCAD requires a PC with:

- Windows 2000, XP, Vista or Windows 7.
- 8 Mb or more (recommended) free disk space
- 16 Mb available RAM

Note: Although PipeCAD is currently compatible with Windows 95, 98, and NT, its use on those platforms is unsupported, as they are no longer supported by Microsoft.

Fire Dynamics Simulator software

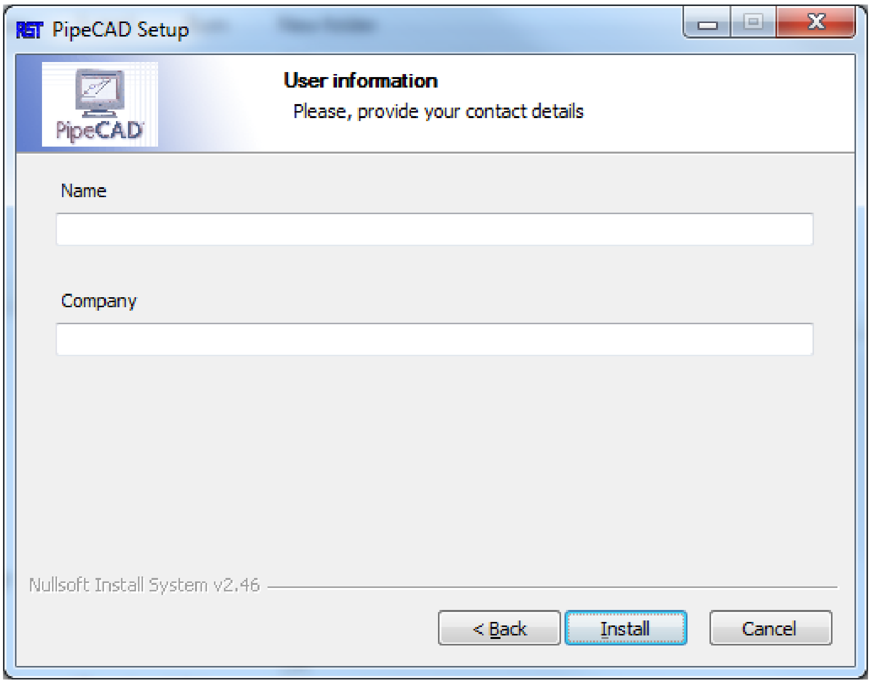
PipeCAD supports NIST’s Fire Dynamics Simulator Version 4.x and 5.0. Visit the Fire Dynamics Simulator Web site (www.fire.nist.gov/fds) for more information about FDS.

Installing PipeCAD

The PipeCAD program is provided on a CD-ROM and installs quickly and easily.

To install PipeCAD:

1. Insert the CD and wait for a window to appear.
2. On the menu that automatically appears, click Software.
3. Select PipeCAD Pipe Modeler from the list of available software.
4. Click Next to begin the Installation Wizard.
5. Accept the license Agreement.
6. Path: Confirm that the pathname displayed is the desired destination location for the software. To specify a different location, enter it in the Destination folder box.
7. Click OK to continue installation of the software.
8. The Set Installation Details window opens, as shown below.



9. Name, Company: Enter both personal and company names to personalize the software.

   Note: Once installed, the program can be opened from the Windows Start > Programs > PipeCad folder.

Chapter 7
Using PipeCAD

Summary

This chapter explains how to use PipeCAD pipe modeling software.

Content

Introduction

This chapter explains how to use PipeCAD pipe modeling software. It covers how to start the program and create a new project or open an existing project. An overview of the PipeCAD menu bar and toolbars is also provided in this chapter.

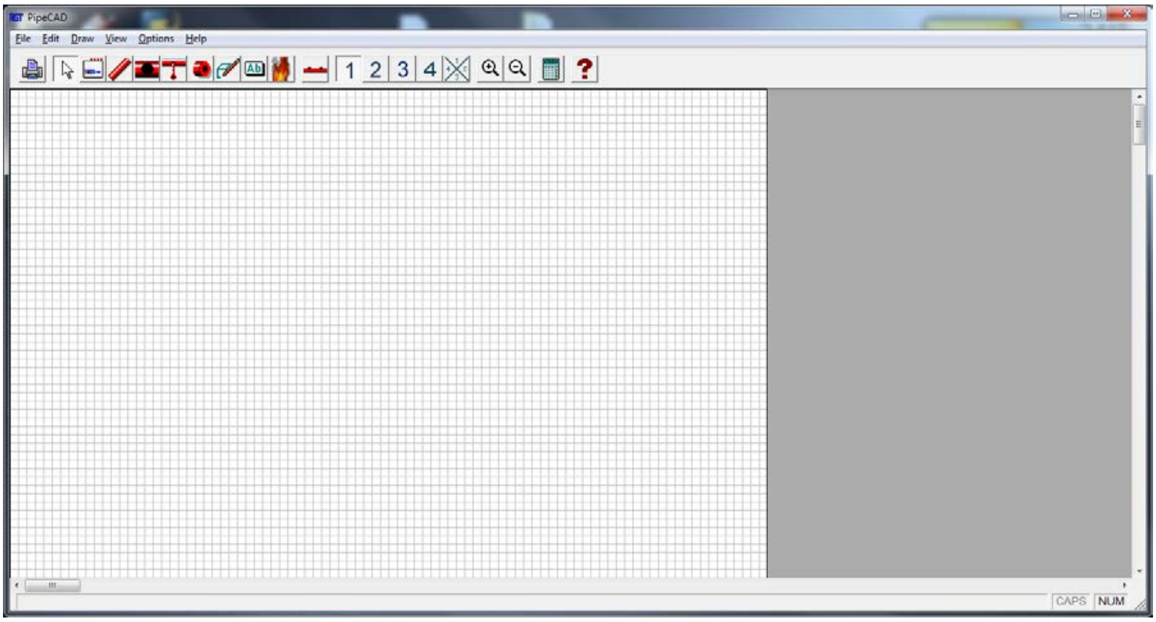
Starting PipeCAD

Once installed, PipeCAD can be started from the Windows Start > Programs > PipeCad folder.

The PipeCAD window

The PipeCAD window shown in Figure 32 below opens when the program is started. The menu bar at the top of the window contains the PipeCAD commands, arranged on drop-down menus. A toolbar containing shortcuts for the most commonly-used menu commands is located at the top of the window.

Figure 32: PipeCAD window



Creating a new project

To create a new project, on the File menu, click New to start a new pipe layout or click Fast Setup for a step by step complete setup for the new project (recommended).

Note: Choosing this command automatically closes any file that is currently loaded. If modifications have been made to the current file, PipeCAD prompts you to save the file before closing it.

Opening an existing project

To open an existing project:

1. On the File menu, click Open.

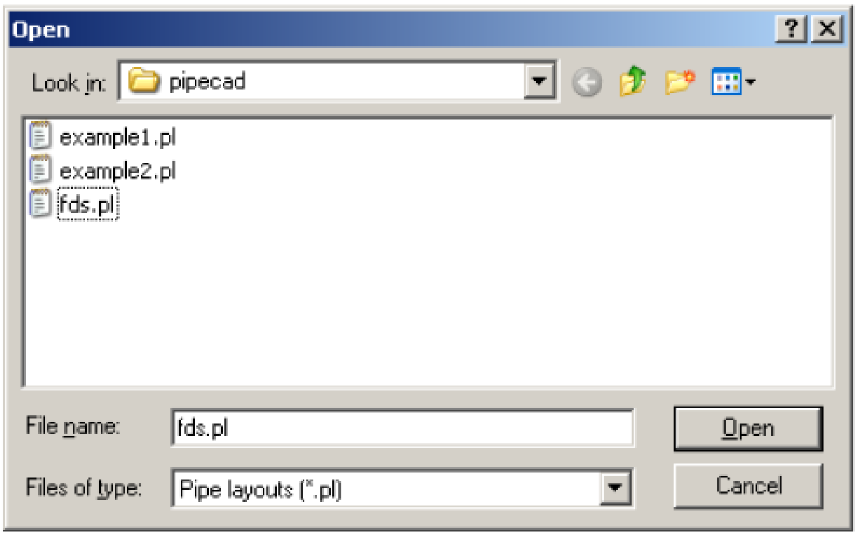
   The Open dialog box appears. (See Figure 33 below.)

2. Select the desired file from the default working directory (C:\pipecad) or use the Windows navigation controls to browse to a different directory.

   Filename extensions for PipeCAD layout files end in ".pl".

3. Select the desired file, and then click Open to load the project.

Figure 33: Open dialog box



Overview of the PipeCAD toolbar

The toolbar (see Figure 34 on page 74) contains shortcuts for the most commonly-used PipeCAD menu commands.

Figure 34: The PipeCAD toolbar

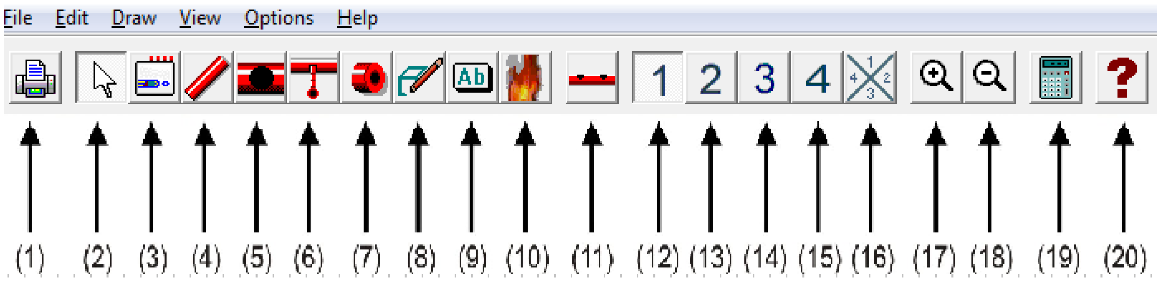


Table 6: PipeCAD toolbar

Item	Icon	Description
(1)	Printer	Prints the current page to the printer specified in the Print Setup dialog box.
(2)	Edit Mode	Enters Edit mode. Pipes may be lengthened by dragging on their ends. Double-clicking an object opens Edit dialog box where the object attributes can be changed.
(3)	Detector Add	Adds detector to the layout at the mouse position. Typically, the detector position is set first in a layout. Note that only one detector per layout is permitted.
(4)	Pipe Add	Adds a pipe to the layout. A pipe is drawn by dragging the mouse until the desired length is reached (as displayed in the Toolbar Status Indicator located at the bottom left of the PipeCAD interface).
(5)	Hole Add	Adds a hole to any pipe. A hole is added by clicking on a pipe. The current settings in the Default Hole Sizes Menu are used. Note that there is a limit of 25 holes per pipe run.
(6)	Capillary Add	Adds a capillary to a pipe. A capillary is added by clicking on a pipe.
(7)	Endcap Add	Adds an end cap to the end of a pipe (to end the current pipe run). An end cap is added by clicking the end of the pipe. Note that an end cap must be placed on the end of each pipe prior to performing flow calculations.
(8)	Outline Add	Draws the room outline for the pipe layout. The outline is drawn in a color that is different than the color of the pipes. A segment of the room outline is drawn by dragging the mouse until the desired length is reached (as displayed in the Toolbar Status Indicator located at the bottom left of the PipeCAD interface), and continuing until the room is completed.
(9)	Label Add	Adds a label at the mouse position. To insert a label, drag the mouse pointer until the desired label size is achieved. Text can then be added by typing directly inside the resulting label box.
(10)	Burner Add	Adds a burner to the layout.
(11)	Automatic Hole Add	Automatically adds holes or capillaries at user-defined spacing along the sampling pipe. When this button is selected, the Auto Hole Placement dialog box opens. After the settings are entered, clicking OK begins the automatic placement of holes.
(12)	Pipe 1 Selector	Displays Pipe 1 only.

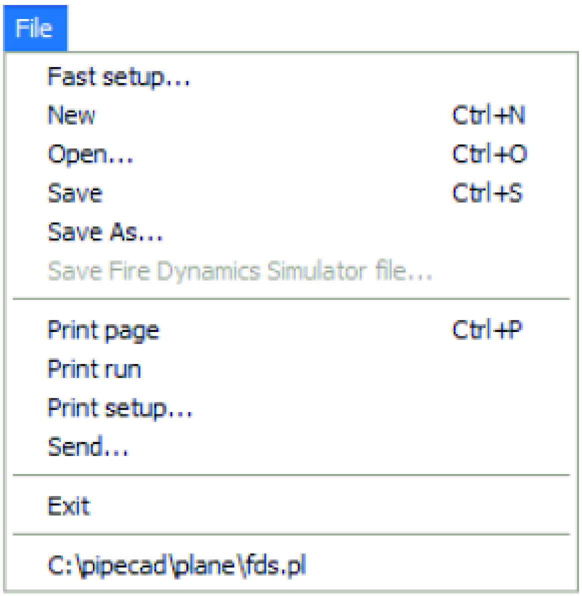
Item	Icon	Description
(13)	Pipe 2 Selector	Displays Pipe 2 only.
(14)	Pipe 3 Selector	Displays Pipe 3 only.
(15)	Pipe 4 Selector	Displays Pipe 4 only.
(16)	All Pipes Selector	Displays all pipes. Note that it is not possible to add any objects to the layout while in the All Pipes display mode.
(17)	Zoom In	Zooms in on the layout by the prescribed amount.
(18)	Zoom Out	Zooms out on the layout by the prescribed amount.
(19)	Calculate	Displays the Calculate menu which lets you specify the calculation type and desired settings before launching flow analysis.
(20)	Help	Opens the built-in Help system.

Overview of the PipeCAD menus

The File menu

Use the File menu (see Figure 35 below) to load and save files, print hard copies of pipe layouts, and exit the program.

Figure 35: File menu



Fast setup: Fast setup is designed to guide you through all of the steps required to enter a full pipe layout complete with an area outline. If a modified layout already exists, you are prompted to save the layout before starting Fast Setup.

New: Clears the current pipe layout from memory. If the pipe layout has changed and has not been saved, you are prompted to save the changed layout.

Open: Opens dialog box prompting you for a filename. Selecting a file or typing its filename loads this layout from disk. The title bar is changed to display the name of the file currently being worked on.

Save: Saves the layout directly to disk, using the current filename (as displayed in the title bar) without prompting you for a filename. If no filename was entered previously, then the Save As dialog box is displayed.

Save As: Opens a dialog box, prompting you for the filename for the new file. The file is saved using this name. The title bar is changed to display the new name.

Save Fire: Dynamics Simulator file: Saves the entered pipe layout in a format that can be used by NIST’s Fire Dynamics Simulator (FDS) to model the complete system performance to an incident. This item is available only if FDS is installed and flow calculations have been performed. (See “Fire Dynamics Simulator software” on page 68 for details of the FDS support.)

Print Page: Prints a hard copy of the currently displayed page on the printer selected in the Print Setup menu.

Print Run: Prints a hard copy of the pipe layout, schedules, and results (if valid) of the current pipe run on the printer selected in the Print Setup menu.

Print setup: Opens a dialog box to let you set the default printer type, paper size, and orientation.

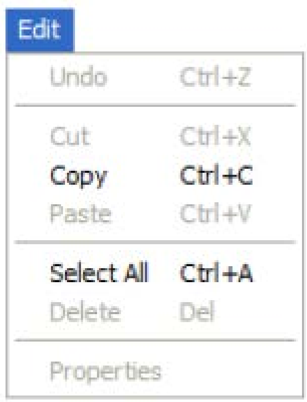
Send: Sends the loaded pipe run layout as an e-mail attachment. This feature is only available if e-mail is enabled on the PC running PipeCAD.

Exit: Ends the program. If the current layout has not been saved, a dialog box displays, prompting you to save the file before exiting.

The Edit menu

Use the Edit menu (see Figure 36 below) to cut and paste parts of pipe layouts on-screen.

Figure 36: Edit menu



Undo: Reverses the effect of the last operation. This command is only available if a previous operation was performed.

Cut: Moves the selected object or objects to the clipboard and deletes them from the pipe layout. This command is only available when one or more objects are selected. The current contents of the clipboard are overwritten.

Copy: Copies the selected object or objects to the clipboard. This command is only available when one or more objects are selected. The current contents of the clipboard are overwritten. Once an object has been copied to the clipboard, it may be pasted into any application that supports import of Windows metafiles.

Paste: Copies one or more objects to the layout from the clipboard. The objects in the clipboard must have been stored with a previous Copy or Cut command. This command is unavailable if the clipboard is empty.

Select All: Selects all objects displayed in the current layout.

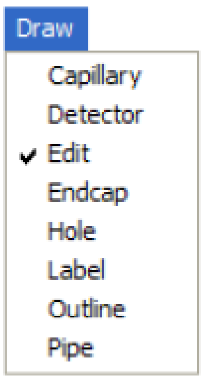
Delete: Deletes the selected object or objects. This command is only available when one or more objects are selected.

Properties: Edits the selected properties of one or more objects, such as position and size. This command is only available when one or more objects are selected. This command can also be issued by double-clicking on an object in Edit mode.

The Draw menu

Use the Draw menu (see Figure 37 below) to either insert a new object into the layout (via Draw mode) or edit an existing object (via Edit mode).

Figure 37: Draw menu



Capillary: Draws a capillary wherever you click. Capillaries can only be placed on pipes. To alter a capillary tube length, double-click on it to open a size dialog box.

Detector: Draws an outline of the detector. All pipes start from the middle of this symbol.

Edit: Sets the current mode to Edit mode. Clicking on an object selects it, and its position can then be moved or its size changed. Double-clicking on an object opens a dialog box where its attributes may be changed.

Endcap: Draws an end cap in the default size. End caps can only be placed on the ends of pipes. To alter the size of the end cap, double-click on it to open a size dialog box.

Hole: Draws a hole in the default hole size. Holes can only be placed on pipes. To alter the hole size, double-click on it to open a size dialog box.

Label: Sets the current mode to label. Double-clicking inside the grid opens the label properties dialog box.

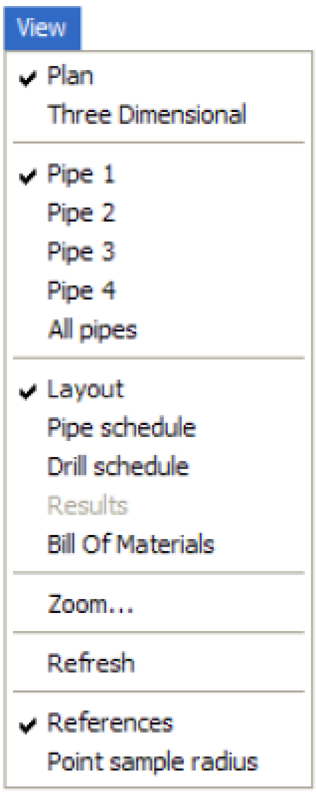
Outline: Use the outline command to draw the room outline that the pipe layout is to protect. The outline is drawn in a different color from the pipes. To alter the size, double-click the outline to open a size dialog box.

Pipe: Dragging draws a pipe of the required length. As the pipe is being drawn in the layout, its length is displayed in the Toolbar Status Indicator located at the bottom left of the PipeCAD window. To alter the size of the pipe, double-click on it to open a size dialog box.

The View menu

Use the View menu (see Figure 38 below) to show the pipe layout in plan or three-dimensional view, to set the pipe run to display, and to set the zoom level.

Figure 38: View menu



Plan/Three-Dimensional: There are two view modes to display the layout in: plan or three-dimensional. Select one of these menu items to set the desired view mode.

Pipe 1/Pipe 2/Pipe 3/Pipe 4/All Pipes: These menu items select which of the four possible sampling pipe runs is currently being worked on. Clicking All Pipes displays all of the pipe runs simultaneously. The layout cannot be edited with All Pipes selected.

Layout/Pipe Schedule/Drill Schedule/Results/Bill of Materials: Selects whether the layout, schedules, or bill of materials is displayed on-screen. The results screen can only be displayed once the pipe calculations have been performed and results exist.

Zoom: The on-screen layout can be enlarged or reduced for ease of viewing using the dialog box opened by this command.

> **Zoom In:** Clicking this menu item zooms in on the layout by the prescribed amount.
>
> **Zoom Out:** Clicking this menu item zooms out from the layout by the prescribed amount.

Refresh: Clicking this menu redraws the display screen.

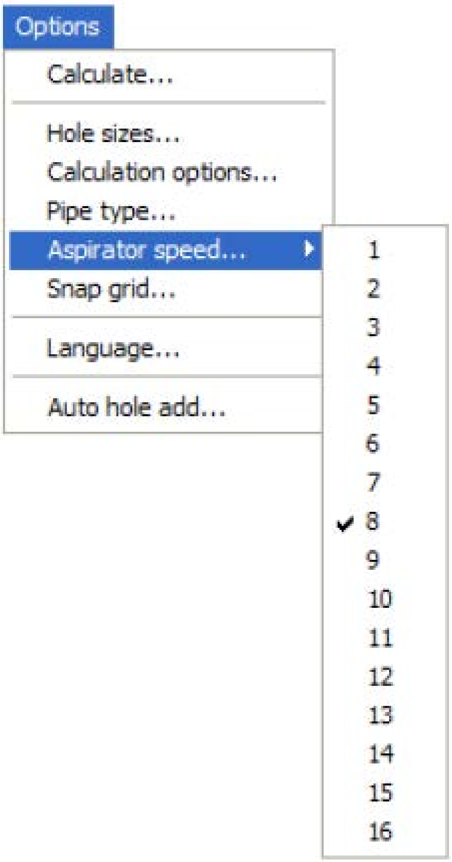
References: Clicking this item enables or disables display of the hole and pipe references. This can make the viewing of complex layouts easier.

Point sample radius: Clicking this item enables or disables display of sampling point radii for each sampling point on the pipe layout. This feature helps when designing system to a specified grid spacing.

The Options menu

Use the Options menu (see Figure 39 on page 80) to calculate flows, display pipe and drilling schedules, set the pipe type, set the default hole sizes, and set the aspirator speed. All of the options set in this menu are saved to disk so that your preferences are stored for future use.

Figure 39: Options menu



Calculate: Displays the Calculate dialog box. The results screen can be viewed once a calculation has been successfully completed.

Hole sizes: The default hole, end cap, capillary sizes, and bend radius used when adding a hole to the layout are set in this dialog box.

Calculation options: This dialog box sets up the way that the hole sizes are changed to optimize the flow balance when calculating the best hole sizes. The maximum allowable transit time (from the end cap) is set for the maximum permissible transit time option. The detector sensitivity that is used to calculate the sampling hole sensitivity and detector type are also set in this dialog box.

Pipe type: There are various pipe types defined as standard, and one of these can be selected in this dialog box. If no standard pipe type is considered suitable, then a new pipe type can be defined by entering its internal diameter and wall thickness.

Aspirator speed: The aspirator speed must be set to the same speed as that of the detector when installed to get an accurate estimation of smoke transit times. The number of speeds shown varies with the detector type selected in Calculation options.

Snap grid: All entered holes are set to multiples of the snap grid size. The size of this grid can be changed if required. When drawing sampling pipe arrangements on-screen, the snap grid allows directional changes to be made

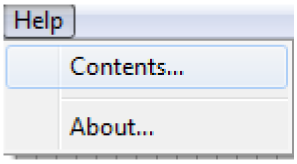
only in the correct engineering drawing perspective. If unusual pipe lengths are required, then the snap grid must be changed to allow the correct lengths of pipe to be entered. The snap grid can be set to be visible or invisible. Text and symbols on the layout are scaled to the snap grid size to enable easier viewing.

Auto hole add: Clicking this item opens the Auto Hole Add dialog box. This allows automatic placing of holes on the sampling pipe at appropriate positions, greatly speeding up entry of pipe layouts. Holes are added starting at the specified “distance to first hole from detector,” working away from the detector and progressing at intervals set by the “hole every after that” entry box until the end cap is reached on the pipe.

The Help menu

Use the Help menu (see Figure 40 below) to start the online Help system and to determine the version of PipeCAD that is installed.

Figure 40: Help menu



Contents: Clicking Contents presents a Table of Contents, which highlights the most important topics in the PipeCAD online Help system.

About: Clicking About presents a window where the version of PipeCAD is presented, in addition to information about the registered user and company name.

Chapter 8
Designing the layout

Summary

This chapter provides general design guidelines and also specific instructions on how to design a pipe layout using PipeCAD.

Content

Introduction

This chapter provides general design guidelines and also specific instructions on how to design a pipe layout using the PipeCAD pipe modeling software.

General guidelines for designing a layout

PipeCAD supports the design and verification of a single detector system. When multiple detectors are required to protect an area, the design must be split into separate layouts for each detector.

Up to four-pipe runs can be entered, each sampling pipe run being made on a separate screen page. The current pipe that is being worked on is selected from the View menu by selecting the pipe run number. All pipe runs can be displayed simultaneously, but no objects can be added when this option is selected.

Each pipe run starts from the center of the detector symbol (a blue square) and finishes at an end cap hole or capillary. Placing holes anywhere other than on the pipework causes an error message to be displayed. Deleting or moving a pipe also deletes or moves all holes placed on that pipe.

Pipe runs can be entered in either plan or three-dimensional view. Note that if the layout is entered in plan view, then no height information is entered in the layout (all vertical heights are assumed to be zero). Any vertical drops in the pipes must be entered afterwards by changing to three-dimensional entry mode.

In three-dimensional mode, PipeCAD has to calculate 3D coordinates from the two-dimensional information entered. The way it calculates this is by using the position of existing objects; thus, there are limitations about the sequence in which objects can be entered. Pipes, for instance, can only be added to the end of existing pipes or to the detector so that their positions can be calculated correctly.

Sampling pipe basics

The following guidelines should be considered when designing a sampling pipe layout.

- The ideal internal diameter of sampling pipes is 3/4 in. (20 mm) with an outside diameter of 1 in. (25.4 mm).

- Ideally, if the total length of sampling pipe is greater than as specified in “Recommended maximum pipe length” on page 28, then multiple pipes should be used to keep transport time within reasonable limits. When using multiple sampling pipes, care should be taken to achieve a reasonable degree of balance to ensure even suction from the pipes.
- T joints are not recommended, as better performance is usually obtained by not using them, although this program does support Ts if their use is unavoidable.

Caution: This program has been designed for calculation within well-defined detector limits. Exceeding these limits can give inaccurate results. If you exceed these limits (which are outside of pipe design rules), results cannot be guaranteed and may possibly be inaccurate.

The design cycle

The design cycle—the process for modeling a basic system design—is as follows:

1. Set the position of the detector in the room. A schematic view of the detector is displayed on all pipe runs in the same position and orientation.
2. Draw the room outline and outline all partitioning in the room, if required. This outline appears on all pipe runs in pale green. If the layout is being produced in three-dimensional view, then attaching a temporary line to the detector fixes the 3D coordinates of the outline.
3. Draw the pipe layout from the detector using the area drawings to get accurate lengths for all pipe runs. Note that for each run of pipe from the detector, there is a selection on the View menu to display that pipe run. The pipe lengths, label text, or hole sizes can be edited by double-clicking the object while in Edit mode. This opens the appropriate properties dialog box.
4. Calculate the smoke transit time and pipe balance by clicking Options > Calculate or by selecting the calculator icon on the toolbar. Click View > Results to review calculated data.
5. If the balance of flow is poor and the calculation has been done with set hole sizes, then the hole sizes can be changed manually and the results recalculated, or alternatively, use the Change Hole Sizes setting on the calculate dialog box. The hole sizes are then modified automatically within preset limits to balance the flow.
6. Check the transit time and individual hole sensitivity results against the required national specification.
7. If the transit time is longer than required, try increasing the aspirator speed above the factory default setting of “8” (if applicable) or recalculate for maximum allowable transit time.

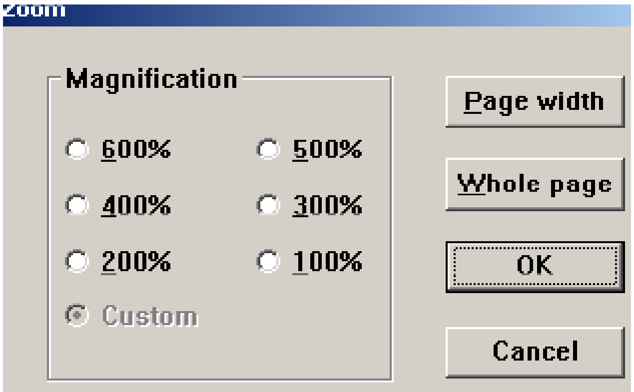
8. Manual editing of hole sizes is permitted in the results screen. Double-click a hole and a dialog box opens. Flows are recalculated every time a hole size is changed.

Setting preferences

Zoom options

To set the desired magnification, click View > Zoom or use the toolbar icons. The following dialog box opens (see Figure 41 below).

Figure 41: Zoom dialog box



Magnification: Click the desired page magnification (in percent).

Page Width: Fits the view to the width of the page.

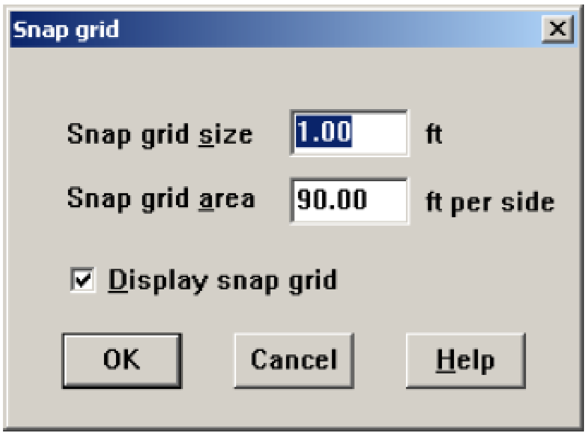
Whole Page: Fits the view to the entire page (recommended).

Snap grid options

Room outlines and sampling pipes are drawn as a series of straight lines. The snap grid ensures that drawn objects are fully controlled in their length. To draw an object, the left mouse button is held down, anchoring the start of the new line to the nearest grid intersection, and the mouse cursor is dragged on the screen. When the left mouse button is released, the end point snaps to the nearest grid intersection.

To set the snap grid parameters, click Options > Snap Grid. The following dialog box opens (see Figure 42 on page 87):

Figure 42: Snap Grid dialog box



The Snap Grid settings control how fine the divisions of the snap grid are, that is, the smallest length increment allowed for drawn lines. The settings in this dialog box are effectively used to set up a scale for the layout. Click OK to save the settings when you are done.

Snap Grid Size: Enter the measurement in feet that the grid paper should represent, permitting a small allowance for a border.

Snap Grid Area: Enter the value which denotes the size represented by each box within the grid.

Display Snap Grid: Select this check box to display the snap grid; clear the check box to hide the snap grid in the PipeCAD window.

2D versus 3D coordinate system

Two options are available when selecting the view in the View menu: Plan or Three Dimensional.

Plan: Clicking this item sets up a two-dimensional view of the layout in which an overhead view is drawn of the installation. Any point on the drawing is specified by two coordinates.

X (width = left to right on the screen)
Z (depth = up and down on the screen)

Note: When designing a layout in the Plan coordinate system, remember to add the additional pipe required to reach ceiling level or make an allowance when considering transport times.

Three-Dimensional: Clicking this item sets up a three-dimensional view of the layout in which the Plan view becomes the horizontal plane in an isometric view and points are specified in three coordinates.

X (width = left-right)
Y (height = up-down)
Z (depth = diagonally at 45 degrees)

Creating the design

When creating a layout, it is recommended that the following objects be added in order:

1. Building outline
2. Detector
3. Pipes
4. End caps, sampling holes, and capillaries

Using the optional Fast setup

If room details are unimportant, Fast setup is a very quick way of generating an aspirating smoke detector layout. Click File > Fast setup to begin.

You are prompted to enter the length, width, and height of the protected area. A three dimensional room outline is automatically created. You are then prompted for the height of the detector above the floor and prompted in Plan view to place the detector. At each stage, when Fast setup is reselected, you are prompted for the next stage of the system design. Fast setup ends by calculating the results.

Importing an AutoCAD DXF file

Although only vertical and horizontal lines can be drawn with PipeCAD, more complicated outlines can be drawn in a CAD package, saved as an industry-standard AutoCAD DXF file, and then imported into PipeCAD. Using File > Open, open the Files of Type drop-down box to select “DXF files (*.dxf)” and browse to the relevant DXF file. Click OK, and the file is imported as a PipeCAD building outline.

Drawing objects in draw mode

In draw mode, the following built-in items can be inserted into the layout.

Room Outline: Use the Outline Add icon on the toolbar or Draw > Outline to draw the room outline for the pipe layout. The outline is drawn in a color that is different than the color of the pipes. A length of the room outline is drawn by pressing down the leftmost button of the mouse until the desired length is reached (as displayed in the Toolbar Status Indicator located at the bottom left of the PipeCAD interface) and continuing until the room is completed. If a mistake is made, click the arrow icon from the toolbar, click on the relevant line to select it, and then press the Del key.

Items such as doors can be shown to give some idea of scale to the layout.

Detector: Use the Detector Add icon on the toolbar or Draw > Detector, and then click to place a detector into the layout. Typically, the detector position is set first in a layout.

Only one detector per layout is permitted.

Pipes: Use the Pipe Add icon on the toolbar or Draw > Pipe to draw a pipe into the layout. A pipe is drawn dragging the mouse until the desired length is reached (as displayed in the Toolbar Status Indicator located at the bottom left of the PipeCAD interface).

Remember to first select a numbered icon on the toolbar or View > Pipe1/2/3/4 to represent the pipe port used on the detector.

Holes: Use the Hole Add icon on the toolbar or Draw > Hole to add a hole to any pipe. A hole is added wherever you click the mouse. The current settings in the Default Hole Sizes Menu are used.

There is a limit of 25 holes per pipe run (applies to two- and four-pipe detectors only).

Capillaries: Use the Capillary Add icon on the toolbar or Draw > Capillary to add a capillary to any pipe. A capillary is wherever you click the mouse.

Endcaps: Use the Endcap Add icon on the toolbar or Draw > Endcap to add an end cap to the end of a pipe (to end the current pipe run). An end cap is added by clicking at the end of the pipe.

An end cap must be placed on the end of each pipe prior to performing flow calculations with Options > Calculate.

Labels: Use the Label Add icon on the toolbar or Draw > Label to insert a label at the mouse pointer location. To insert a label, drag until the desired label size is achieved. Text can then be added by typing directly inside the label box.

Editing objects in edit mode

There are two ways to enter edit mode:

- Click Draw > Edit. When Edit appears with a check mark in the Draw menu, PipeCAD is in edit mode.
- Click the Edit icon on the toolbar. When the Edit icon is depressed, PipeCAD is in edit mode.

Items can be moved or adjusted using edit mode.

Moving an object: Select an object with the mouse (the object turns red). Drag the object to the desired location.

Moving multiple objects: Drag a box around the objects to be moved (the objects turn red). Press and hold the Shift key while you drag the objects to the new location.

Changing an object's attributes: In Edit mode, if an object is double-clicked, a dialog box displays the object's attributes, such as size (for holes) or length (for capillaries or pipes). An object's attributes can be changed directly in the dialog box and are updated immediately in the layout. Table 7 below provides a list of the editable parameters for each object.

Table 7: Parameters that can be modified in edit mode

Object	Parameter
Detector	X-Y-Z coordinates
Pipe section	Pipe section length, beginning and end X-Y-Z coordinates
Sampling hole	Hole diameter, X-Y-Z coordinates (must be on a pipe)
Capillary	Capillary length, hole diameter, X-Y-Z coordinates (must be on a pipe)
Endcap	Hole diameter, X-Y-Z coordinates (must be on a pipe)
Building outline	Line section length, beginning and end X-Y-Z coordinates
Label	Label text, label width and height, display or hide label bounding box, X-Y-Z coordinates

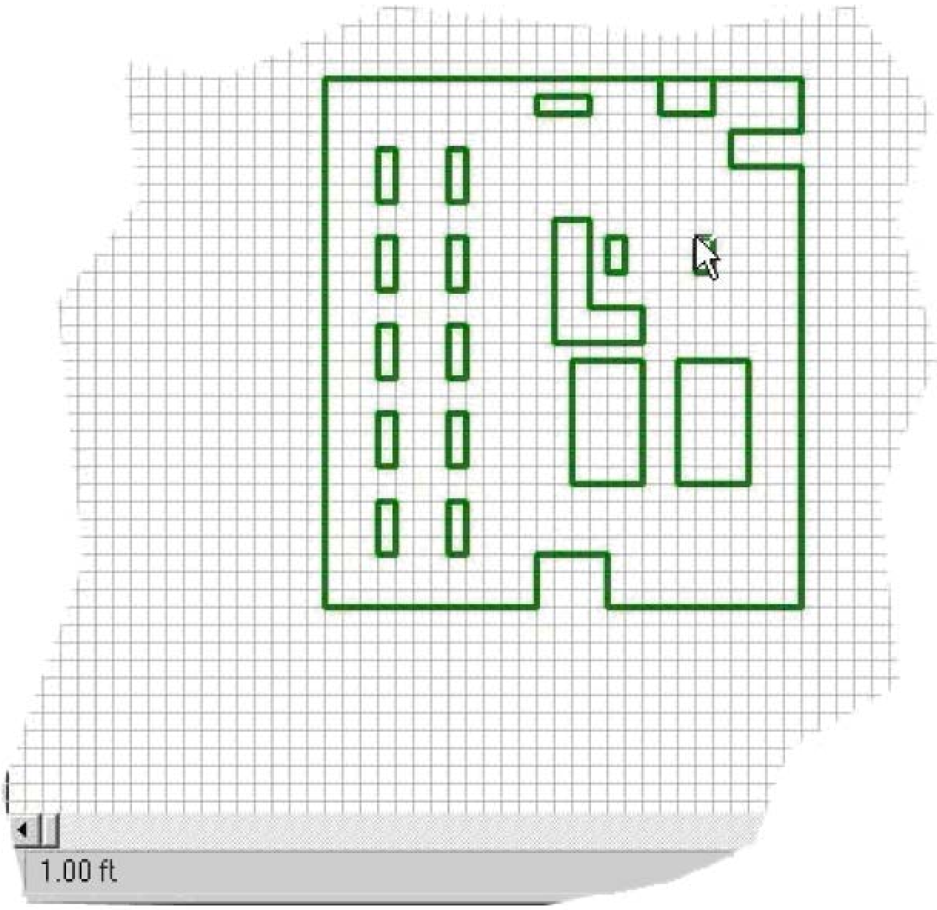
Example of a layout

The next pages provide an example of a design to discuss the steps involved in creating a layout.

Inserting the room outline

Click the Outline Add icon (see Figure 34 on page 74) on the toolbar, or click Draw > Outline to begin drawing the outline. See Figure 43 on page 91.

Figure 43: Inserting the room outline



In Figure 43 above, the outline of a building has been drawn by dragging a series of straight lines, shown in green. The line is not finalized until the mouse button is released, so adjustments can be made to length while drawing. When the button is released, the drawn line becomes a drawing object.

The position of the mouse cursor shows that a line is now being drawn. The indicator at the bottom left of the screen shows the current length of the drawn line so that lengths are kept accurate. In this example, the snap grid is set to 1 foot spacing, so the lengths of all lines are exact multiples of 1 foot.

Once the Plan view is drawn, the full three-dimension layout can be added. The first step is to select the three-dimensional view and locate the position of the detector.

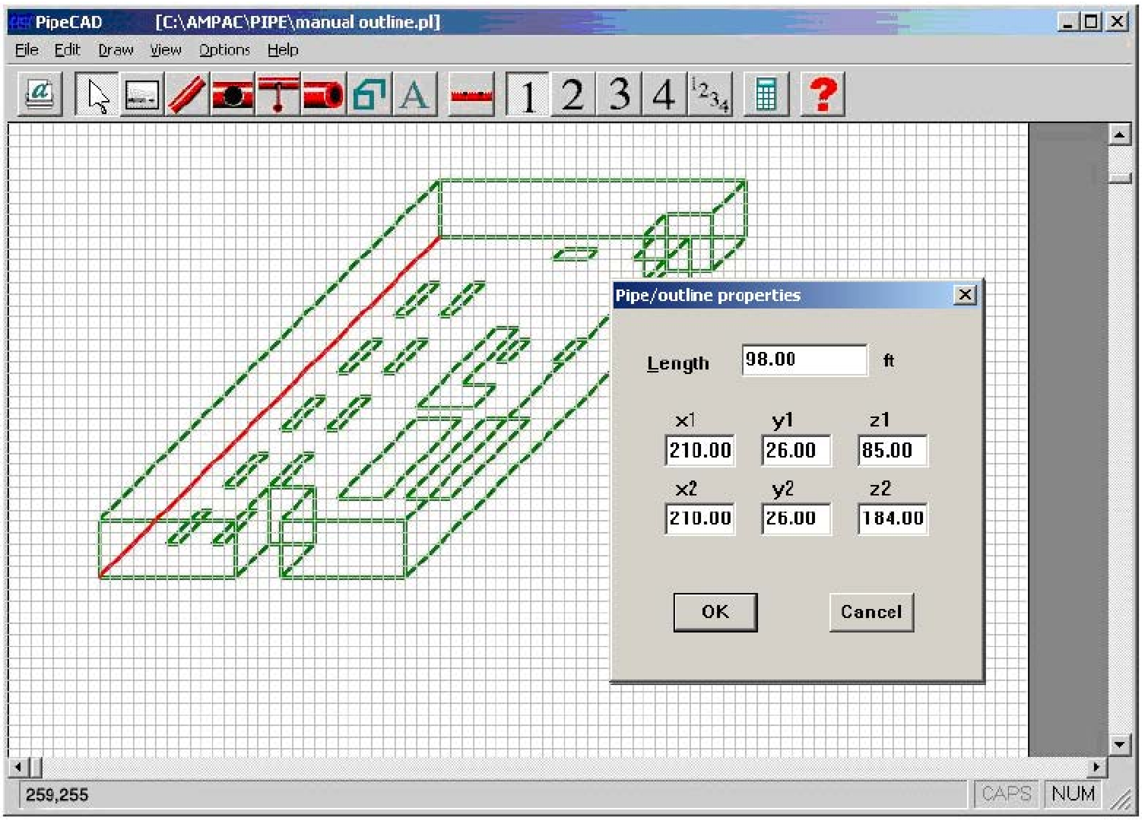
Showing the room outline in three dimensions

To change to a three-dimension view, click View > Three Dimensional. The three-dimensional view may be in an awkward position to edit, but it can be moved by entering Edit mode. In Edit mode, drag to create a dotted line around the drawing. Ensure that all lines have turned from green to red, and Shift-drag the outline to the desired position. (Hold the Shift key while dragging with the left mouse button.)

This method (extended selection) can be used to move any group of lines on the screen. Clicking a single line to turn it red allows it to be moved on its own. (The Shift key does not need to be held down in this instance.) When the outline has been moved to the desired position, click Draw > Outline again.

We can now add the remainder of the room outline. The easiest way to do this is to draw the vertical risers from the corners of the room, dragging out to the appropriate length (in this example, the room is 16 ft. high) and drawing lines between the risers. See Figure 44 below for the completed outline.

Figure 44: Completed outline



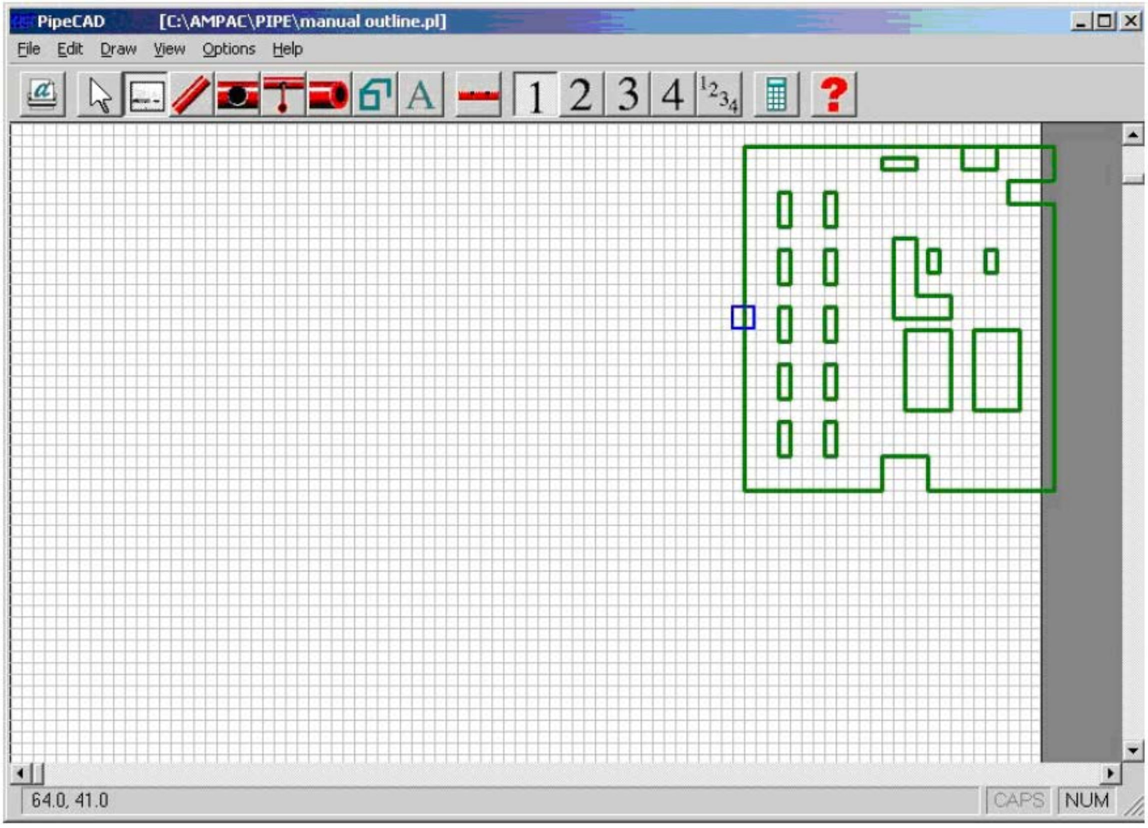
The next stage is to locate the detector in three-dimensional space. To provide a reference, the bottom line of the left hand wall has been selected by left-clicking in Edit mode to turn it red. Double-clicking the line brings up its dimensional properties. The length of the wall (98 ft.) is shown, as well as the start (X1, Y1 and Z1) and finish (X2, Y2 and Z2) three-dimensional coordinates of the line.

The indicator at the bottom left of the screen shows the current Z and X coordinates of the mouse pointer. We will use this to locate the detector. We will use the three-dimensional coordinates shown in the above example as a reference.

Placing the detector in the outline

We know that the Z and Y scales increase from the top of the screen to the bottom. Assuming that we wish the detector to be approximately halfway along the left-hand wall, 10 feet up, the detector must have coordinates X = 210.0, Y = 16.0 (subtracting 10 feet from the wall's Y1 coordinate) and Z = 135.0. (Since the wall is approximately 100 feet long, we need to add 50 feet to the wall's Z1 coordinate.)

Figure 45: Placing the detector in the outline



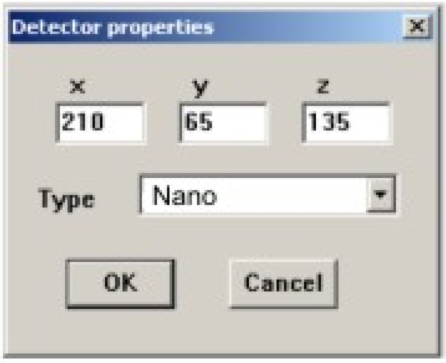
It is easier to place the detector in the Plan view. Click View > Plan.

Once in Plan view, click Draw > Detector and move the mouse pointer until the coordinate display reads "210.0, 135.0." Click to place the detector into the outline. It appears as a blue square.

Note: Switching to plan view has moved part of the outline off the grid, but it can be dragged and dropped to move it again if necessary.

Having placed the detector in two dimensions, we need to locate it accurately in the third. Entering edit mode and double-clicking the detector opens the Detector Properties dialog box as shown in Figure 46 on page 94.

Figure 46: Editing the detector properties



You can see that, although the X and Z coordinates are correct, the Y (height) coordinate is incorrect. Enter “16” in the Y box. The detector coordinates are now correct. Click OK to save the coordinates and close the dialog box.

Inserting the sampling pipes

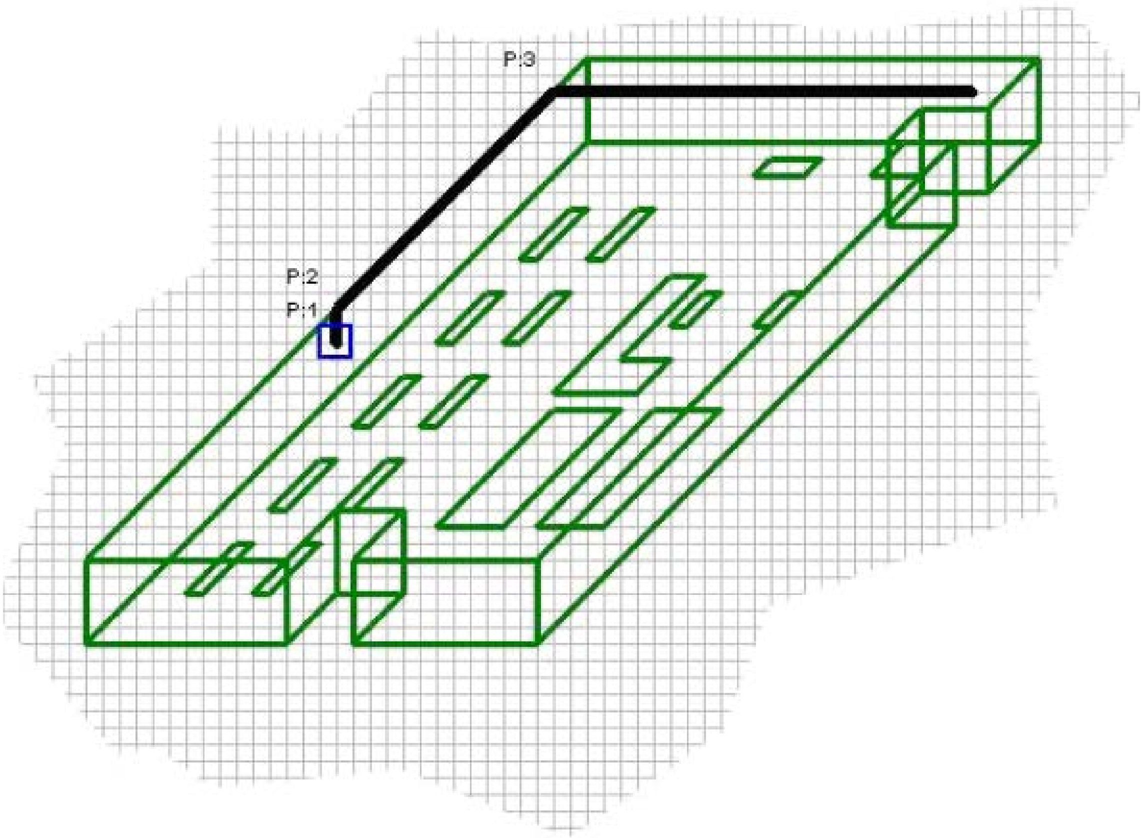
Once the detector is in place, we can start to add the sampling pipes. Select the three-dimensional view again with View > Three Dimensional. The pipes are drawn one at a time on separate screens, one for each pipe. At the top of the screen is a row of five numbered icons as shown in Figure 47 below.

Figure 47: View pipe icons

These icons relate to the pipe number being worked on. There is a separate view for each pipe to avoid confusion. Drawing, editing, and viewing results is performed on a single pipe at a time. The rightmost icon in Figure 47 (All Pipes View) can be selected to show the view for all pipes simultaneously. Pipes cannot be added or edited, and results cannot be viewed while “All Pipes” is selected.

Sampling pipes are drawn in the same way as the building outline, by drawing a series of straight lines. All pipes must originate in the center of the square blue detector icon. Click Draw > Pipe and ensure that the “Pipe 1” icon is depressed. An example of a drawn pipe is shown in Figure 48 on page 95.

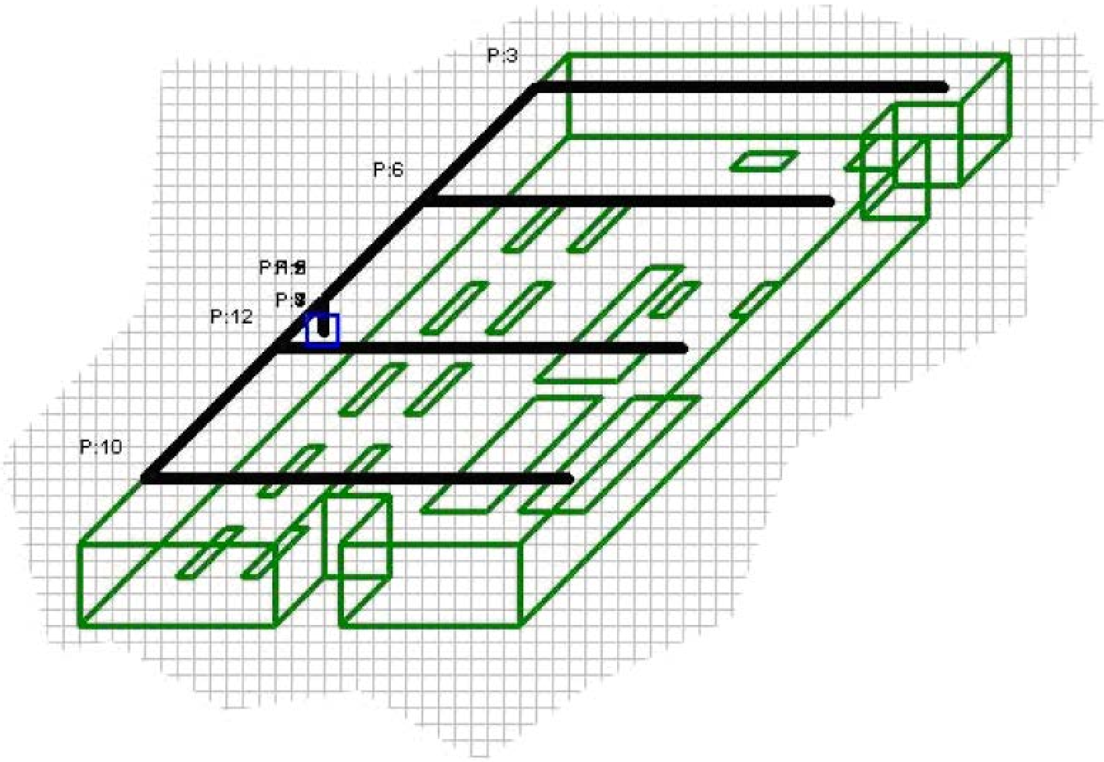
Figure 48: Drawing pipe 1



This has been drawn in three sections, P1 to P3, each one identified separately by the software. Observe that the 6.5 ft. section, P1, which leads from the detector to the ceiling, starts in the center of the blue detector icon. For the pipes to be properly arrayed in three-dimensional space, they must be drawn from the detector outwards.

The process is repeated for each pipe, from 1 through 4 as applicable, in the same manner. The separate screens for each pipe ensure that there is no confusion between pipe runs. When complete, the layout as seen in the “all pipes” view is as shown in Figure 49 on page 96.

Figure 49: All pipes in layout



Inserting end caps

Before we can add any sampling holes, we need to add an end cap for each pipe. All pipes must be fitted with end caps. PipeCAD does not allow you to add sampling holes before this is done.

To add an end cap to a pipe, click the “Pipe 1” icon, and then click Draw > Endcap. Click the end of the pipe to place the end cap. Repeat for the remaining sampling pipes 2 through 4, as applicable.

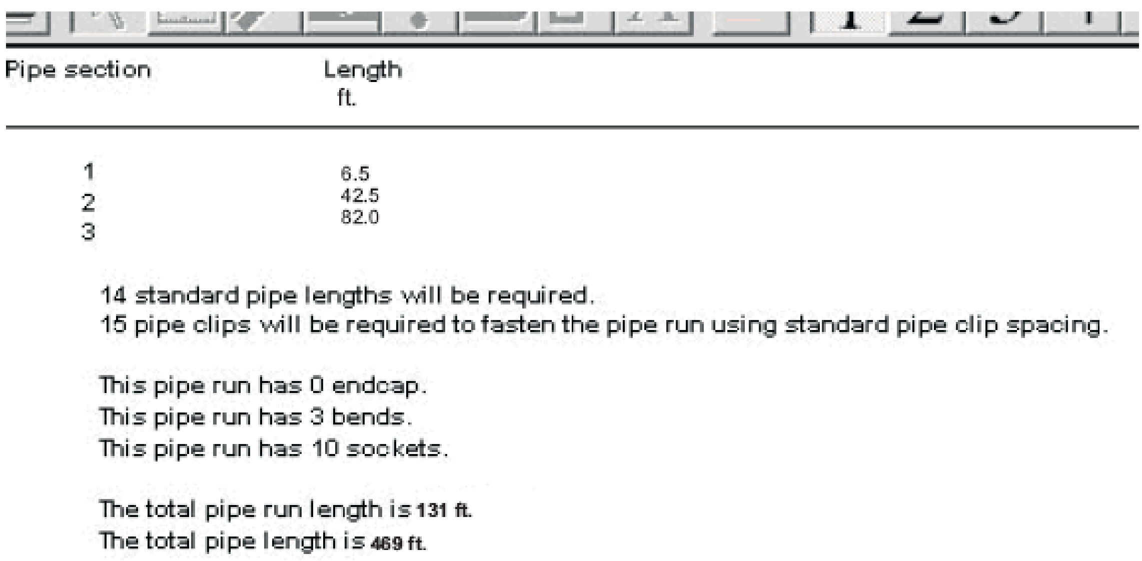
Inserting sample holes

The next stage is to add the sampling holes. To add holes manually, click Draw > Hole. Select the pipe button corresponding to the pipe that you wish to add the hole to, and click to place the sampling hole on the pipe.

If desired, there is an easier method of placing sampling holes on the pipes: Auto Sampling Hole Add lets you specify the position of the first hole from the detector and the spacing of holes thereafter.

Click View > Pipe schedule. For pipe 1, the information shown in Figure 50 on page 97 appears.

Figure 50: Pipe schedule report



Pipe section	Length ft.
1	6.5
2	42.5
3	82.0

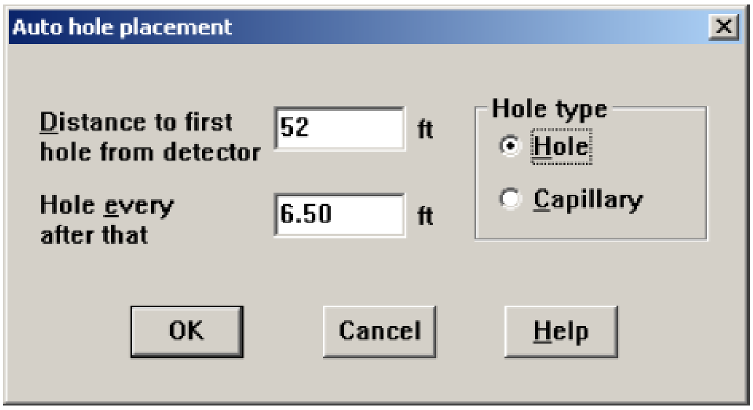
14 standard pipe lengths will be required.
15 pipe clips will be required to fasten the pipe run using standard pipe clip spacing.

This pipe run has 0 endcap.
This pipe run has 3 bends.
This pipe run has 10 sockets.

The total pipe run length is 131 ft.
The total pipe length is 469 ft.

It can be seen that the main pipe run (Pipe section 3) begins 49 ft. from the detector and runs for 82 ft. It would seem convenient to make the first hole at 52 ft. and additional holes every 6.5 ft. after that. To do this, click Options > Auto Hole Add. The Auto Hole Placement dialog box opens as shown in Figure 51.

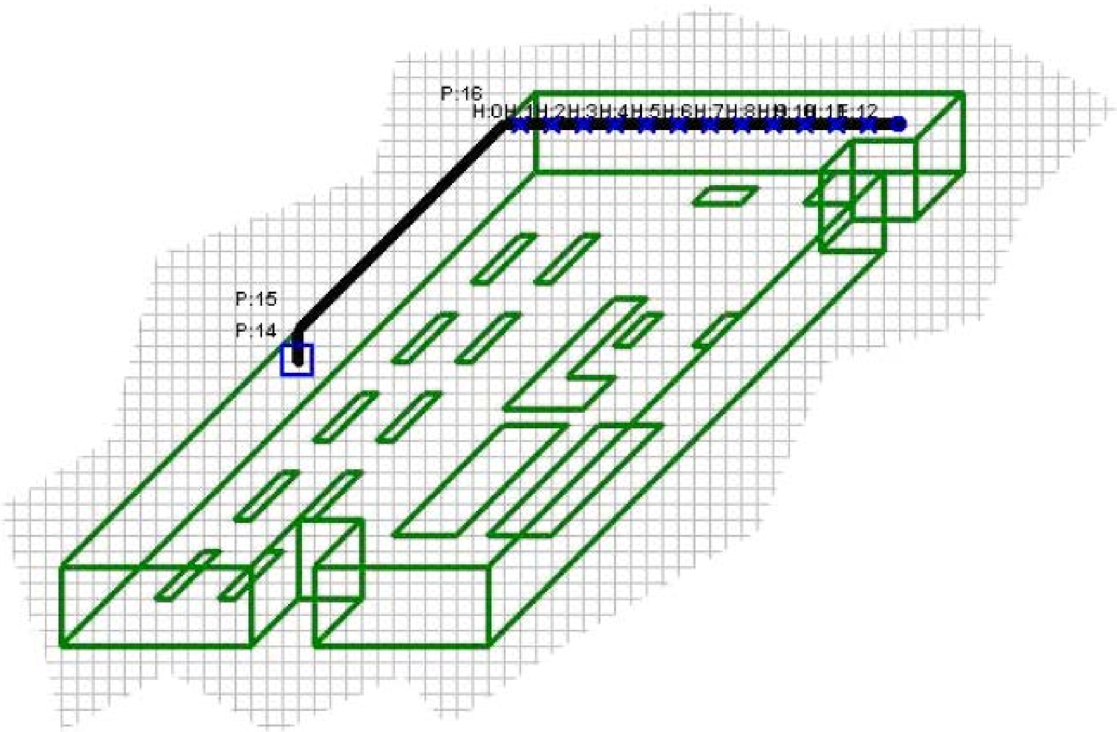
Figure 51: Auto Hole Placement dialog box



The Hole Type options can be used to insert capillary sampling points instead of plain sampling holes. To automatically enter sampling holes, type “52” in the “Distance to first hole from detector” box and “6.50” in the “Hole every after that” box. Click OK to continue.

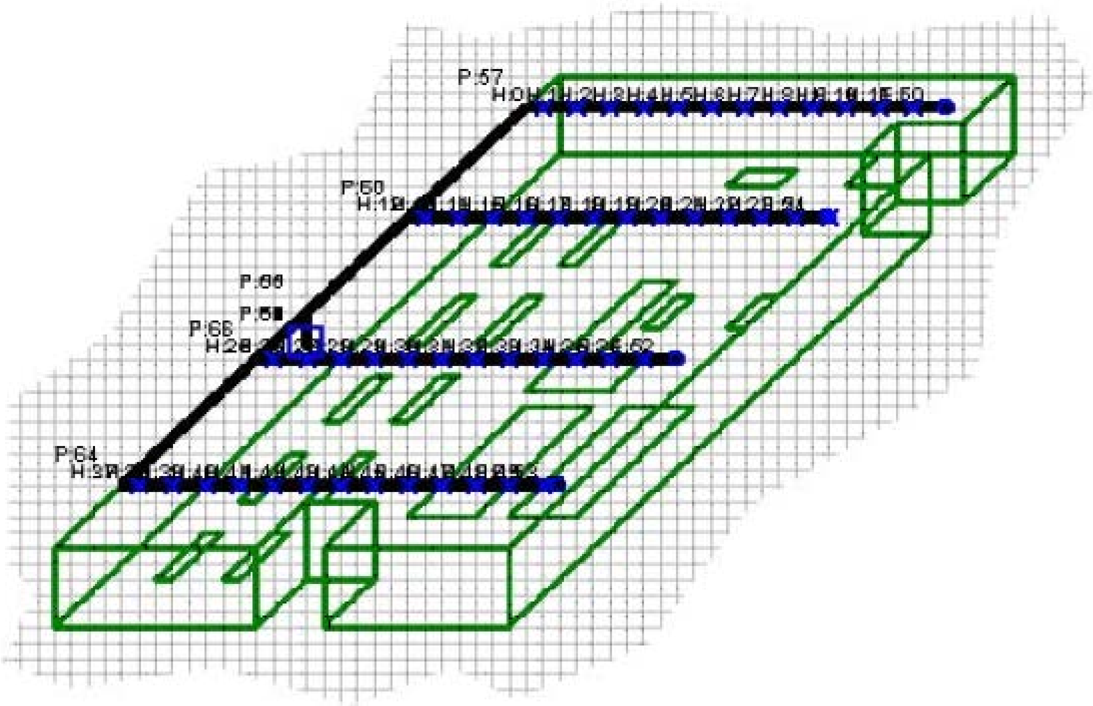
A warning message appears stating that all existing holes and capillaries on the pipe will be deleted. Click OK to continue. The layout shown in Figure 52 is displayed.

Figure 52: Automatically adding sampling holes



Repeat this process for the remaining sampling pipes as required. A completed layout, viewed in “all pipes” mode, is shown in Figure 53 below.

Figure 53: Completed four-pipe layout

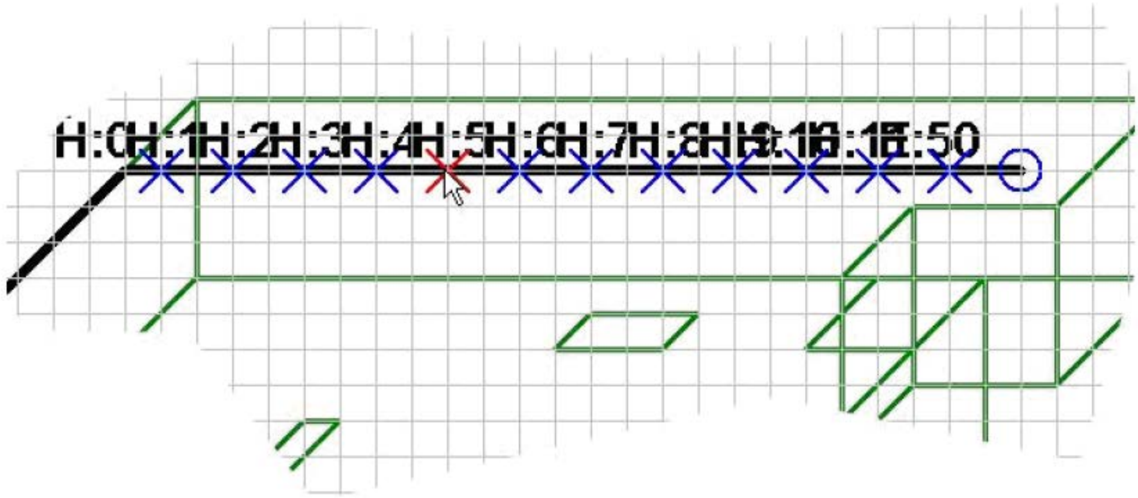


Inserting capillaries

The same procedure can be followed using capillary sampling points rather than plain sampling holes. To add a single capillary sampling point in place of a plain sampling hole, delete the relevant hole by clicking to select it (it turns red) and then pressing the Del key. Click Draw > Capillary to add capillary points.

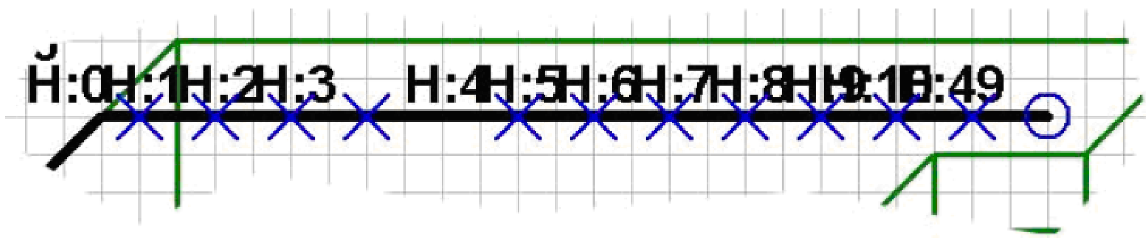
For example, let us assume that in the above example we wish to replace sampling hole 4 on pipe 1 with a capillary sampling point with a 6.5 ft. capillary length. Select pipe 1. Click Draw > Edit to enter Edit mode. Select hole 4 as shown in Figure 54 below.

Figure 54: Selecting hole 4



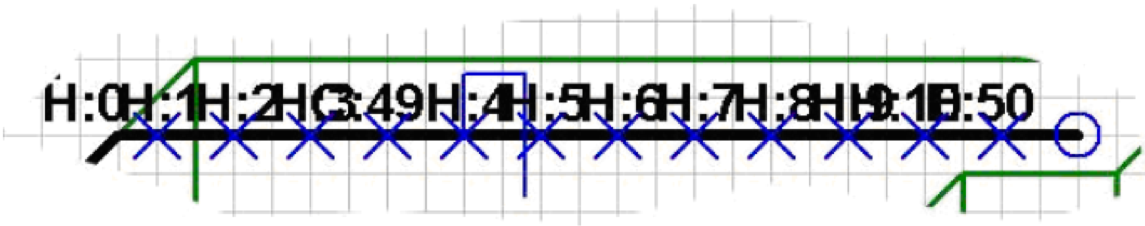
Pressing the Del key deletes the sampling hole and renumbers the remaining holes as shown in Figure 55 below.

Figure 55: Deleting hole 4



Next, click Draw > Capillary. Click the pipe where the deleted hole was. The snap grid ensures that the correct spacing is maintained.

Figure 56: Adding a capillary



The capillary has now been added. For a sampling hole, the only relevant parameters are the hole diameter and its coordinates. Capillary sampling points have the additional property of length, which can be edited in Edit mode.

This completes the pipe layout design phase. The final phase is to use PipeCAD to analyze and verify the layout. Refer to Chapter 9 “Verifying the layout” on page 101 for more information.

Note: Remember to save your file often when designing a layout. In addition, making a backup copy of your file is highly recommended.

Chapter 9
Verifying the layout

Summary

This chapter explains how verification of the pipe layout is performed in PipeCAD pipe modeling software, including the options that you can set.

Content

Introduction

This chapter explains how verification of the pipe layout is performed in PipeCAD pipe modeling software, including the options that you can set.

Considerations

The main considerations when designing an aspirating smoke detector layout are: per-hole sensitivity and smoke transport time.

For example, a smoke transport time must not exceed more than 120 seconds from the farthest sampling hole from the detector.

What happens during calculation

PipeCAD's process of verifying the layout is explained below:

1. The pipe run must be an unbroken chain of pipes starting at the detector and finishing at the end cap. The first thing that occurs when calculating is to check the entered pipe run to see that it is valid. If it is not valid, an error message is displayed and the calculations are not carried out.
2. If the pipe run is valid, the calculation moves to the next phase: "exploding" the pipe run into sections, each with a pipe length and hole. Each section then has flow calculations performed on it.
3. The calculations are completed next. The results are now checked against the required limits and, if necessary, the calculation phase is repeated with new hole sizes until within the set limits.
4. The sensitivity of each sampling hole is displayed using the values that you enter in the Calculate > Options dialog box. These values should match the value that is indicated on the histogram viewer after the detector protecting the room has completed its FastLearn process.

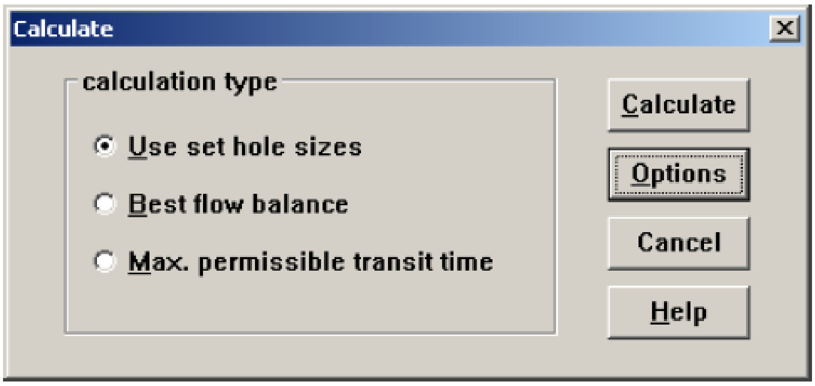
Entering calculation options

After the designer is satisfied with the layout, the calculation options should be specified.

Selecting calculation type

Clicking Options > Calculate opens the Calculate dialog box (see Figure 57 on page 103) which lets you set parameters for the verification process.

Figure 57: Calculate dialog box



Use set hole sizes: Select this option if it is essential to have complete control over the hole sizes. Only flow calculations are performed. Sampling hole and capillary tube sizes are not modified during verification of results.

The default hole sizes used when adding holes to the layout can be changed with the Options > Hole Sizes command.

Best flow balance: Select this option to allow individual hole sizes to be modified within the limits specified in the Hole Calculation Options dialog box to achieve a balance of flow that is within the limit set. No checks are made on the transit time. Note that this option is the default setting and is appropriate for most scenarios.

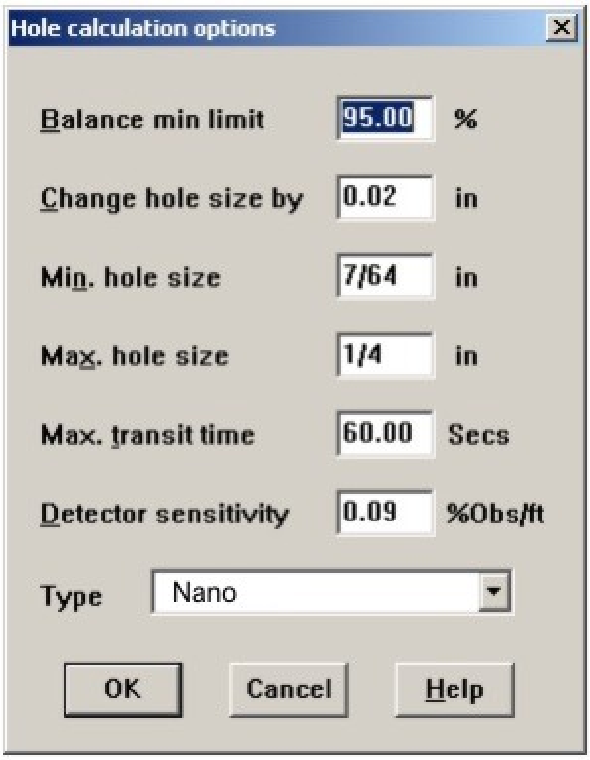
Max. permissible transit time: Select this option when transit time is the most critical aspect. The flows are balanced as with the Best Flow Balance option, but when this is accomplished, the transit time is checked to make sure that it is within the required limit. When the transit time is outside the set limit, the hole sizes are adjusted to decrease the transit time.

After the calculation type is selected, click Options to continue.

Selecting calculation options

Clicking Options opens the Hole Calculation Options dialog box as shown in Figure 58 on page 104.

Figure 58: Hole calculation options dialog box



Balance min limit: This is used for “best flow balance” type calculations and specifies how closely the sampling pipes should match each other in total airflow rate (the minimum percentage of balance that must be achieved by the flow calculations). A closely balanced system gives the best results. If this balance cannot be achieved, a warning is displayed.

Change hole size by: PipeCAD automatically adjusts hole sizes to give the best flow balance between pipes and between holes on the pipes. This value determines the minimum step in hole size by which the software can adjust the hole sizes when making calculations (the amount that each hole size can be modified each time a flow calculation is performed). Set this to match your drill sizes.

Min and Max hole sizes: These are the smallest and largest sizes that a hole can be set to when trying to balance the hole flows. These may be specified in relevant documentation or specifications.

Max transit time: This is the maximum allowable transit time when calculating using a “maximum permissible transit time” type calculation. The hole sizes are increased, if necessary, to try to reduce the transit time. If the required transit time cannot be achieved, a warning is displayed.

Detector sensitivity: This is the sensitivity of the main detector fire alarm. This varies depending on the cleanliness of the protected area. Unless you are able to leave a detector in the protected area for 24 hours to assess this, the value included here must be a best estimate based on experience. The default value of 0.1%/m should be adequate for nonsmoking office areas and clean rooms.

This entry may be set to the value indicated on the histogram viewer or the detector self-test after the detector has completed its FastLearn process so that the sensitivity can be shown at each sampling hole relative to the actual detector sensitivity.

Type: The type of detector to be used. It is very important that the detector type is set correctly to ensure that the calculated flows and sensitivity are correct.

After all options have been specified, press OK to save the settings and return to the Calculate dialog box.

Performing calculations

In the Calculate dialog box, click Calculate to start the verification process. The calculations will take a few moments.

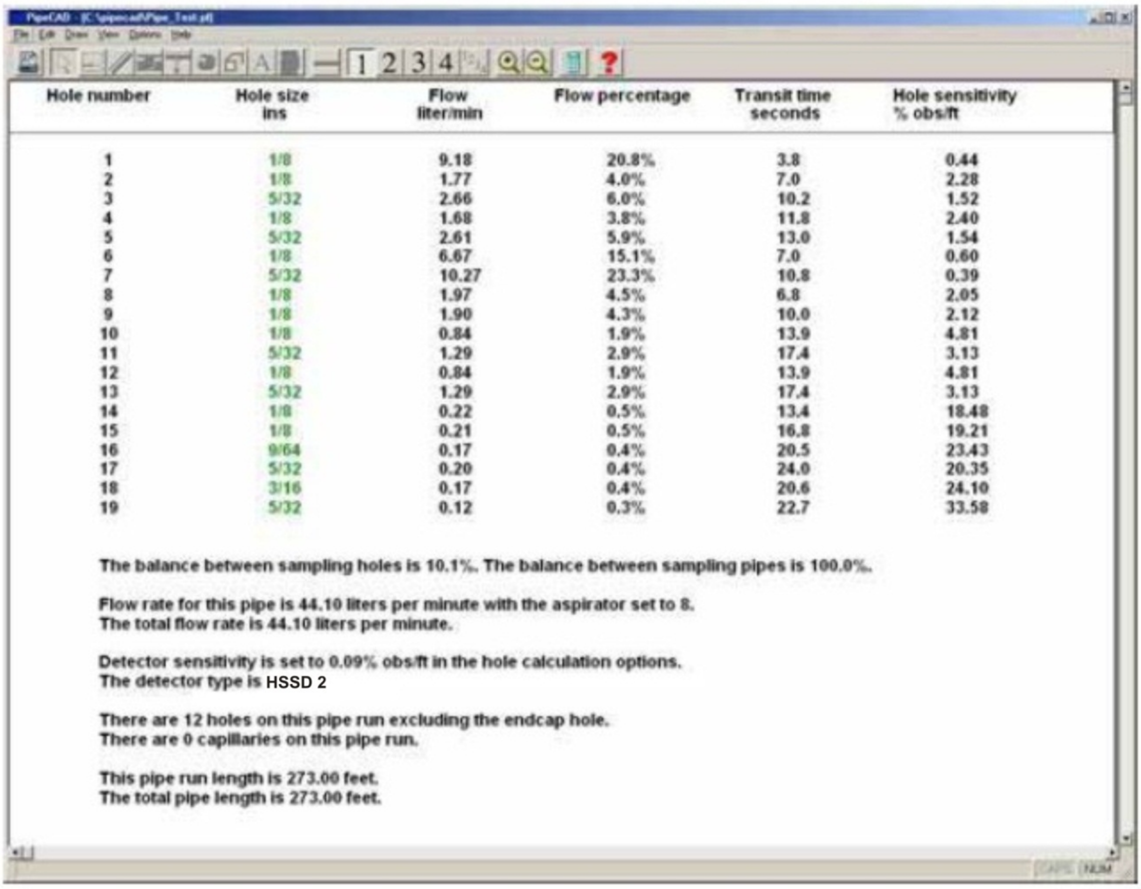
Note: Before clicking Calculate, verify that "Pipe 1" has been selected for view in the layout (by clicking the Pipe1 button on the toolbar or by clicking View > Pipe 1).

Viewing calculation results

Click View > Results to view the calculation results. Refer to Figure 59 on page 106 for a typical results report.

Note: Calculation results are easier to view in the Whole Page zoom mode. Click View > Zoom to select the Whole Page view.

Figure 59: Typical results report



Hole number	Hole size ins	Flow liter/min	Flow percentage	Transit time seconds	Hole sensitivity % obs/ft
1	1/8	9.18	20.8%	3.8	0.44
2	1/8	1.77	4.0%	7.0	2.28
3	5/32	2.66	6.0%	10.2	1.52
4	1/8	1.68	3.8%	11.8	2.40
5	5/32	2.61	5.9%	13.0	1.54
6	1/8	6.67	15.1%	7.0	0.60
7	5/32	10.27	23.3%	10.8	0.39
8	1/8	1.97	4.5%	6.8	2.05
9	1/8	1.90	4.3%	10.0	2.12
10	1/8	0.84	1.9%	13.9	4.81
11	5/32	1.29	2.9%	17.4	3.13
12	1/8	0.84	1.9%	13.9	4.81
13	5/32	1.29	2.9%	17.4	3.13
14	1/8	0.22	0.5%	13.4	18.48
15	1/8	0.21	0.5%	16.8	19.21
16	9/64	0.17	0.4%	20.5	23.43
17	5/32	0.20	0.4%	24.0	20.35
18	3/16	0.17	0.4%	20.6	24.10
19	5/32	0.12	0.3%	22.7	33.58

The balance between sampling holes is 10.1%. The balance between sampling pipes is 100.0%.

Flow rate for this pipe is 44.10 liters per minute with the aspirator set to 8.
The total flow rate is 44.10 liters per minute.

Detector sensitivity is set to 0.09% obs/ft in the hole calculation options.
The detector type is HSSD 2

There are 12 holes on this pipe run excluding the endcap hole.
There are 0 capillaries on this pipe run.

This pipe run length is 273.00 feet.
The total pipe length is 273.00 feet.

Interpreting calculation results

This gives full details for the selected pipe's sampling holes as follows:

Hole number: This is the hole number as shown on the layout drawing.

Hole size: These figures can be changed, if required, by double-clicking and manually changing the hole's diameter. Holes are highlighted in green.

Flow percentage: This is a measure of airflow through the sampling hole as a percentage of the whole pipe's airflow.

Transit time: This is an estimate of the time for smoke to travel from the sampling hole to the detector.

Hole sensitivity % obs/ft per bar: This is the estimated concentration of smoke that needs to be sampled by the hole in order to cause a 1-bar reading on the detector's bar graph. As the default Fire 1 Alarm setting is 8 bars, the figure must be multiplied by eight to give the actual alarm sensitivity of the hole. To find the hole sensitivity of the other relative alarm factors (PreAlarm and Aux), multiply this reading by the alarm level values for those alarms.

The other information on the reports summarizes the balance between pipes, the various options selected, and the pipe lengths used.

Analysis of sample results

The following analysis refers to the results report shown in Figure 59 on page 106.

The worst sensitivity figure in the pipe results is for hole number 65 at 0.79% obs/ft. per bar. Multiplying this by eight gives a Fire 1 Alarm sensitivity of 6.32%. Assuming a worst-case acceptable per-hole sensitivity of 5% obs/ft., this is outside the allowable range and is unacceptable. A higher detector sensitivity could be set in the Hole Calculation Options dialog box to see what the effect of a more sensitive setting would be.

In Hole Calculation Options, we specified a worst-case maximum smoke transit time of 60 seconds. The transit times for all holes fall well within 60 seconds, so this requirement has been met.

Notice that Aspirator speed has been set to 16, which is the maximum settable speed for a four-pipe detector. If desired, the aspirator speed can be decreased slightly by clicking Options > Aspirator speed from the menu and selecting a lower value from the drop-down list. A recalculation can then be performed with Options > Calculate > Calculate.

The balance between sampling pipes is 99.8%, which is above the minimum requirement specified in the Hole Calculation Options dialog box.

Figure 60: Example of a layout verification

Hole number	Hole size ins	Flow liter/min	Flow percentage	Transit time seconds	Hole sensitivity % obs/ft
56	9/64	1.46	5.5%	2.4	0.67
57	9/64	1.45	5.4%	2.6	0.68
58	9/64	1.42	5.3%	3.1	0.69
59	9/64	1.41	5.2%	3.3	0.70
60	9/64	1.38	5.2%	3.9	0.71
61	9/64	1.34	5.0%	5.0	0.73
62	5/32	1.48	5.5%	7.8	0.66
63	3/16	1.30	4.9%	8.2	0.75
64	5/32	1.44	5.3%	9.3	0.69
65	3/16	1.25	4.6%	10.5	0.79
66	5/32	1.40	5.2%	10.9	0.70
67	11/64	1.60	6.0%	11.4	0.61
68	11/64	1.57	5.8%	13.7	0.62
70	11/64	1.54	5.7%	16.5	0.64
69	7/32	1.26	4.7%	17.3	0.78
103	1/4	5.55	20.7%	18.4	0.18

The balance between sampling holes is 71.1% . The balance between sampling pipes is 99.8% .

Flow rate for this pipe is 26.90 liters per minute with the aspirator set to 16.
The total flow rate is 107.50 liters per minute.

Detector sensitivity is set to 0.01% obs/ft in the hole calculation options.
The detector type is Micra 100

There are 0 holes on this pipe run excluding the endcap hole.
There are 15 capillaries on this pipe run.

This pipe run length is 45.00 feet.
The total pipe length is 208.00 feet.

Chapter 10
Additional features

Summary

This chapter discusses some additional PipeCAD features, such as how to generate a bill of materials (BOM) and change part numbers, part descriptions, and the pricing that appears in the BOM.

Content

Introduction

This chapter discusses some additional PipeCAD pipe modeling software features, such as how to generate a bill of materials (BOM) and change part numbers, part descriptions, and the pricing that appears in the BOM. Instructions for editing TUBE.INI file to customize PipeCAD are also provided in this chapter.

Generating a bill of materials

When a PipeCAD design is complete, it automatically generates a complete bill of materials (including pricing) that can be viewed and printed. To see the bill of materials, click View > Bill of Materials. A window with the following details opens as shown in Figure 61 below.

The prices and part numbers for the items can be changed to reflect your own values. Refer to “Customizing PipeCAD” on page 111 of this chapter for details.

Figure 61: Typical PipeCAD generated Bill of Materials

Description	Part number	Quantity	Unit cost	Total cost
Pipe length 3m - red	10900	48	4.35	208.80
Pipe clip - red	10930	54	0.33	17.82
End cap - red	10927	4	0.45	1.80
90 deg. elbow - red	10906	12	2.05	24.60
Socket - red	10908	34	0.45	15.30
			Total	268.32

NIST Fire Dynamics Simulator (FDS) integration

PipeCAD supports NIST’s Fire Dynamics Simulator (FDS), allowing the complete system response time to be modeled. Clicking File > Save Fire Dynamics Simulator File saves the pipe layout in a format that can be used by FDS. See the FDS Web site and application note AN014 for full details of the FDS support.

Note: The item Save Fire Dynamics Simulator File, found in the File menu, is only available if FDS software has been installed on the PC running PipeCAD and flow calculations have been performed by clicking Options > Calculate.

Customizing PipeCAD

PipeCAD has the ability to have a different startup screen, default language, detector names, and pipe information (as shown in the bill of materials). This enables agents or resellers to stamp their own identity on the product. The following instructions describe how to create a custom version of PipeCAD.

Important files

Cautions

TUBE.INI: The sections of this file that not discussed here should not be modified as this may cause incorrect operation of PipeCAD.

Note: The file TUBE.INI is required for the customizations explained below. We strongly recommend that you make a backup copy of the file before you edit them.

TUBE.INI on the installation disk contains many details about the software configuration and is where user customization of pipe information, Web site address, and detector names is done. To modify these settings, edit TUBE.INI with a text editor.

Setting a custom Web site

Clicking Help > About in PipeCAD presents the About dialog box which shows details of program information and also a link to a Web site which customers can open from within PipeCAD. The URL (Internet address) of this site can be modified to point to the site of the agent or reseller.

To specify a custom Web site:

1. In a text editor, locate the following text in the TUBE.INI file:

   ```
   [User]
   WebSite=http://www.airsensetechnology.com
   ```

2. Replace the current Web site URL with the desired Web site URL.

   Note: The prefix “http://” must appear before the address or the Web link feature will not work.

3. If no WebSite entry exists, type the string below the [User] section.
4. Save TUBE.INI.

Setting a custom startup logo

LOGO.BMP contains the startup logo. This file can be replaced with any standard Windows bitmap graphic. The startup window is sized to the bitmap; therefore, any bitmap size can be used.

Note: The filename LOGO.BMP should be used, as this is the default name.

Setting custom pipe details

All pipe fittings and accessories can be stored under their part numbers as shown in the example below.

To modify part descriptions:

1. Using a text editor, locate the following text in the TUBE.INI file:

```
[Descriptions]
10900=Pipe length 3m - red
10906=90 deg. elbow - red
10908=Socket - red
10925=Standard sampling point assembly
10927=End cap - red
10930=Pipe clip - red
```

2. In the `[Descriptions]` section, change the descriptive text for each associated number as desired.
3. Save TUBE.INI.

To modify part numbers:

1. Using a text editor, locate the following text in the TUBE.INI file:

```
[Supplier part numbers]
10900=10900
10906=10906
10908=10908
10925=10925
10927=10927
10930=10930
```

2. In the [`Supplier part numbers`] section, change the descriptive text for each associated number so that the manufacturer part number equals the customer part number.
3. Save TUBE.INI.

To modify prices:

1. Using a text editor, locate the following text in the TUBE.INI file:

```
[Prices]
10900=4.35
10906=2.05
10908=0.45
```

```
10925=8.75
10927=0.45
10930=0.33
```

2. In the [`Prices`] section, change the text for each associated number to the desired price.
3. Save TUBE.INI.

Note: If prices are not stored, they do not appear on the bill of materials.

Setting custom detector names

To rename the detector product names:

1. Using a text editor, add the following text in the TUBE.INI file, within the `[Descriptions]` section:

```
[DetectorNames]
Name0= Micra 100
Name1= Micra 25
Name2= HSSD 2
```

   Example entries for a section defining the default names are shown above. To use alternative names, replace the text after the equals sign. The names need to be changed in the software.

2. Save TUBE.INI.

Setting a default PipeCAD language

To set a default language for PipeCAD:

1. Using a text editor, locate the following text in the TUBE.INI file:

```
[Product]
Language=0
```

2. Refer to Table 8 below to determine the number of the desired language and enter it after the equal sign.
3. Save TUBE.INI.

Note: You can override this setting when installing PipeCAD.

Available languages are shown below in Table 8 below.

Table 8: Supported PipeCAD languages and their number codes

Number code	Language
0	English
1	Estonian
2	Dutch

Number code	Language
3	French
4	German
5	Hungarian
6	Italian
7	Norwegian
8	Portuguese
9	Spanish
10	Swedish
11	English US (Non-Metric Units)
12	Finnish
13	Korean
14	Simplified Chinese
15	Traditional Chinese
16	Polish
17	Russian

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